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Health Anxiety and Online Health Information Seeking: An Experimental Study

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Health Anxiety and Online Health Information Seeking: An Experimental Study

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Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

December, 2019

Abstract

Health Anxiety and Online Health Information Seeking: An Experimental Study

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The University of Texas at Austin, 2019

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Health anxiety is a psychological trait that refers to the tendency to experience health-related worries and fears triggered by misinterpretations of bodily sensations as indicative of serious illness. Recent studies have suggested a possible link between health anxiety and online health information seeking (OHIS). It is evident that people with high health anxiety tend to engage in excessive OHIS when noticing unfamiliar bodily symptoms, but often experience negative affect (e.g., worries and fears about health) during or following the search. As a result, they continue to search for more information to reassure themselves. Despite the current knowledge, much remains unknown about the relationship between health anxiety and OHIS.

This dissertation aimed to further explore the relationships between health anxiety and the way people feel (affective), think (cognitive) and act (behavioral) during OHIS. First, I discussed key concepts and theories related to health anxiety and OHIS. Next, I reviewed empirical studies on relationships between health anxiety and the cognitive, affective and behavioral aspect of OHIS. Based on the reviewed theories and empirical studies, I developed a conceptual framework — eHealth Anxiety Model (eHAM). Guided

by this model, I proposed a series of research hypotheses which state the relationships between health anxiety and six outcome variables that represent the cognitive (perceived health risk), affective (valence, arousal and control) and behavioral (search effort and search outcome) dimensions of OHIS.

To test these hypotheses, I conducted a quasi-experiment in which participants were asked to perform an online search to find out the most likely diagnosis of an illness case. Results of the quantitative analysis revealed that health anxiety and online search had no statistically significant interaction effect on people's cognitive, affective and behavioral experience during OHIS. However, health anxiety did have a significant main effect on perceived health risk, valence and search accuracy. To be specific, participants with higher health anxiety perceived greater health risk about the illness case, experienced greater negative affect overall, and were more likely to find the correct diagnosis than those with lower health anxiety.

This dissertation's theoretical contributions include integrating the theoretical models and concepts from psychology and information science and developing the eHealth Anxiety Model. Results of this study can inform health practitioners and researchers in developing effective interventions for treating online health anxiety.

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Chapter 1: Introduction

Health anxiety is a psychological trait[1] that makes an individual more susceptible to experiences of health-related worries and fears (Asmundson, Abramowitz, Richter, & Whedon, 2010; Asmundson, Taylor, Sevgur, & Cox, 2001; Lucock & Morley, 1996). Current evidence suggests that 2.1% to 17.6% of the general population and 4.5% to 30.6% of the clinical population suffer from high health anxiety (Looper & Dickinson, 2014; Weck, Richtberg, & Neng, 2014). It is believed that high health anxiety is no less common than other major mental disorders, such as major depression, accounting for 6.7% of the total U.S. adult population (Center for Behavioral Health Statistics and Quality, 2016). Research suggests that high health anxiety can undermine people's physical and mental health and interrupt their everyday functioning, such as causing troubled sleeping, frequent panic attacks, and an inability to concentrate on work (Fergus, 2014b).

People with health anxiety may demonstrate a series of cognitive, affective, and behavioral characteristics to various degrees, depending on the severity of the condition. In regard to cognition, individuals with high health anxiety may demonstrate various forms of cognitive biases towards diseases (e.g., catastrophic interpretations of bodily

[1] In the present study, health anxiety is treated as a *trait*, not a *state*. A *state* refers to transitory reactions triggered by specific stimuli and may fluctuate as the situation changes. In contrast, a *trait* is a relatively enduring and stable disposition that is unlikely to change situationally (Izard, 2013). Although not explicitly distinguished in instrument developments, measurements of health anxiety to date seem to incline to treating health anxiety as a trait. They tend to measure individuals' general proneness to illness-related worries and fears, instead of transitory feelings at a given moment. Some example items are: "Are you ever worried that you may get a serious illness in the future?" (Health Anxiety Questionnaire, Lucock & Morley, 1996), "Does the thought of serious illness scare you?" (Illness Attitude Scale, Ferguson & Daniel, 1995), "I constantly have images of myself being ill" (Health Anxiety Inventory, Salkovskis, Rimes, Warwick, & Clark, 2002). Therefore, the present study treats health anxiety as a trait. Note that being a *trait*, it does not mean that health anxiety is not treatable. Same as other psychological disorders (e.g. depression), the condition of health anxiety can be improved with proper treatment and interventions (Taylor & Asmundson, 2004).

symptoms and medical information). In regard to affect, individuals with high health anxiety are likely to develop health-related worries and fears when experiencing unfamiliar symptoms. In regard to behavior, individuals with high health anxiety tend to seek excessive medical consultations from a variety of sources, such as healthcare providers, family members, and the Internet.

For many people, the Internet has become the go-to-place for health-related inquires, despite the fact that they may view their doctors as the most trusted source of health information (dotHealth, 2017). Not only does the Internet offer a wealth of health information and resources, but it has placed it all at the user's fingertips. It is generally believed that active health information seeking can benefit people in many ways, such as improving physiological well-being, reducing uncertainty and anxiety, increasing a sense of control, and promoting health behavior changes (Johnson & Case, 2012).

However, this is not always the case. An early study by White and Horvitz (2009a) discovered that using Web search engines for self-diagnosis may expose users to information on severe medical conditions that may be associated with commonly experienced symptoms, but rarely cause them. For example, there was a 20% chance that a search for headache would return information on brain tumors, and a 37% chance that a search for chest pain would return information about heart attacks (White & Horvitz, 2009a). Exposure to exaggerated medical information is more likely to fuel affective responses (e.g., worries and fears) to medical conditions among individuals with high health anxiety.

Recent studies have suggested a possible link between health anxiety and online health information seeking (OHIS). It is evident that people with high health anxiety tend to engage in excessive OHIS (in terms of long duration and high frequency) when noticing unfamiliar bodily symptoms, but often experience negative affect[2] (e.g., worries and fears) during or following the search (e.g. Baumgartner & Hartmann, 2011; Eastin & Guinsler, 2006). As some have admitted, this is because OHIS often exposes them to alarming information about some serious disease which they tend to link to their symptoms. As a result, they continue to search for more information to reassure themselves (Baumgartner & Hartmann, 2011; Doherty-Torstrick, Walton, & Fallon, 2016; Singh & Brown, 2014). As some researchers (e.g., Baumgartner & Hartmann, 2011) have suggested, under the influence of high health anxiety, Internet users might experience a "vicious cycle": the more they search online, the more they worry, and the more they worry, the more they search online – a phenomenon that the media have coined *cyberchondria*[3] (BBC News, 2001; Rogers, 2000; Valley, 2001). Considering the

[2]*Affect* is considered an umbrella term for all other affect-related terms (e.g., emotions, feelings, and moods) (Batson, Shaw, & Oleson, 1992). As defined by Russell (2003, p. 147), it is a "neurophysiological state that is consciously accessible as a simple, nonreflective feeling that is an integral blend of hedonic (pleasure-displeasure) and arousal (sleepy-activated) values." Health-related negative affect (e.g., worries and fears) is typically triggered when the individual misinterprets bodily symptoms as indications of serious illness. It is important to note that *affect* as defined here is a *state*, not a *trait* – this fundamentally distinguishes affect and health anxiety as two different but associated concepts. The association between health anxiety and affect is that people with health anxiety are more likely to experience certain types of affect (e.g., health-related worries and fears). From here on, the terms *affect* and *affective states* will be used interchangeably to refer to the affective dimension of human behavior.

[3]Starcevic and Berle (2013, p. 2) define cyberchondria as "an excessive or repeated search for health-related information on the Internet, driven by distress or anxiety about health, which only amplifies such distress or anxiety." This definition suggests a reciprocal relationship between two components: distress or anxiety about health and OHIS. Note that "distress or anxiety about health" is not equal to "health anxiety" – the former describes an affective state, whereas the latter is a trait. Such a distinction is subtle but important for clarifying the relationship between cyberchondria and health anxiety. It appears that cyberchondria and health anxiety are two distinct but closely related concepts. *Health anxiety* as a trait

prevalence of health anxiety and the ever-growing number of online health information seekers, the problem of cyberchondria is likely to influence a considerable portion of the population. Hence, more research attention is needed to further investigate this problem.

Despite current knowledge, much remains unknown about the relationship between health anxiety and OHIS. Many models of information seeking (e.g., Information Search Process, Kuhlthau, 1991) have suggested that the process of OHIS involves a series of cognitive (how people think), affective (how people feel) and behavioral (what people do) factors. However, most studies have investigated only two general behavioral factors of OHIS – search frequency and search duration. It is still unclear if and how health anxiety may impact various aspects of the actual search process and search outcomes. As individuals with health anxiety are likely to misinterpret their bodily symptoms as indicative of severe disease (Salkovskis & Warwick, 2001; Warwick & Salkovskis, 1990), such cognitive bias could mislead them to search for and attend only to information on severe illnesses, while ignoring benign explanations, and thus impact their search efficiency and search outcomes. In addition to behavioral factors, it is also unclear if and how health anxiety may impact any cognitive and affective aspects of OHIS, such as people's perceptions of the health information they find online and their feelings during and after searches. This dissertation aimed to explore these issues in order to deepen our understanding of the relationships between health anxiety and OHIS.

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refers to the tendency to experience health-related worries and fears. That is to say, if an individual has health anxiety and performs frequent OHIS, he or she is more likely to experience cyberchondria.

The rest of this dissertation proposal is structured as follows: Chapter 2 reviews the literature on relevant topics, including health anxiety, OHIS, and their relationships. Chapter 3 proposes a conceptual framework and research hypothesis based on theories, models, and empirical findings identified in the literature. Chapter 4 describes the research method. Chapter 5 presented the results. Chapter 6 includes discussions of the major findings, contributions of the dissertation, and research limitation and future directions.

Chapter 2: Literature Review

To better understand the major concepts (health anxiety and OHIS) as well as their relationships, I conducted a comprehensive review of the literature published in the fields of information science and psychology, following three steps:

Step 1: I reviewed the research on the relationships between health anxiety and OHIS to identify the knowns and unknowns, with particular attention on theories and the methods used to conduct such research. With the completion of step 1, I was able to identify major research gaps, based on which I formulated the initial research questions.

Step 2: One of the conclusions drawn from step1 is that current studies show a lack of theoretical guidance. This is to be expected, considering that research on the relationships between health anxiety and OHIS is still in its infancy. One solution is to develop a conceptual framework based on theories found in the two relevant domains of health anxiety and OHIS. Thus, I reviewed the literature on health anxiety, during which I identified a leading theory of health anxiety – the cognitive-behavioral model of health anxiety. This model establishes a theoretical foundation for understanding the development and maintenance of health anxiety.

Step 3: As the research goal is to understand the relationships between health anxiety and the cognitive, affective, and behavioral aspects of OHIS, a model that would be helpful for guiding the current research should address all three of these aspects of OHIS. However, research on health information seeking has rarely studied the affective dimension of OHIS. Thus, I decided to broaden my review to include models of general

information seeking. Upon completing step 3, I discovered three models that are particularly helpful for guiding the proposed research: Kuhlthau's Information Seeking Process Model (Kuhlthau, 2004), Nahl's Socio-Biological Information Technology Model (Nahl, 2007b) and Griffin's Risk Information Seeking and Processing Model (Griffin, Dunwoody, & Neuwirth, 1999). These three models, combined with the cognitive-behavioral model, provide a solid theoretical foundation for the present study.

Figure 1 illustrates a roadmap of the covered topics. Below, I will review the key concepts, theories, and research findings related to these topics.

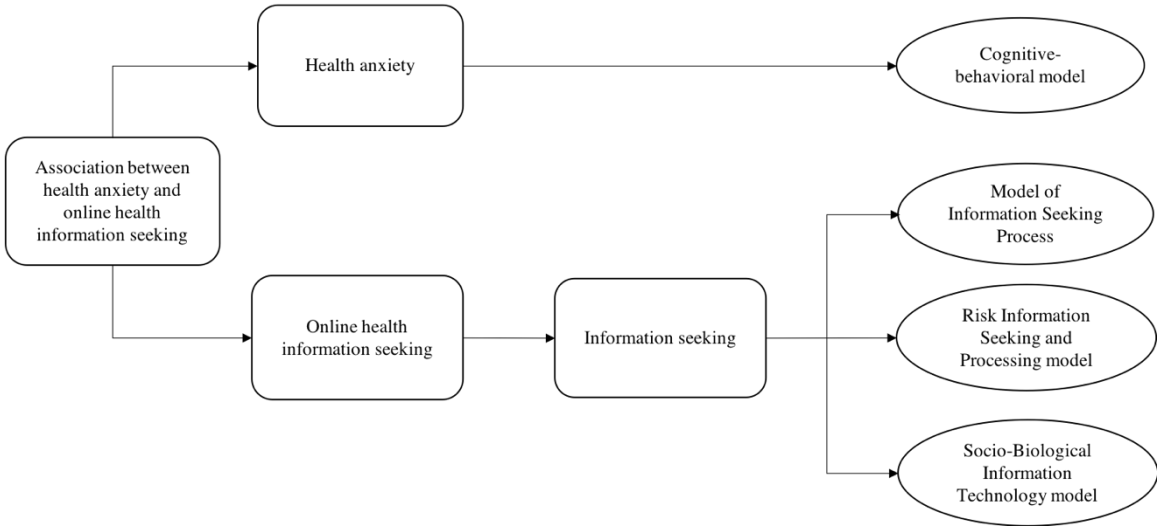

Figure 1: Roadmap of the literature review process.

2.1 UNDERSTANDING HEALTH ANXIETY

> *I've always been a worrier. When my older sister developed breast cancer all my worries began to focus on my health and my chance of getting cancer… Barely a day goes by without me worrying that I might have breast cancer… I used to see my doctor all the time for checkups… Yesterday I started to worry so much that I started to panic. I felt shaky, nauseous, and lightheaded and was certain that I was going to die… (Asmundson, Taylor, & Cox, 2001, p. 3)*

2.1.1 Defining health anxiety

The narrative above is from someone who suffers from high health anxiety. *Health anxiety* is the tendency to experience health-related worries or fears triggered by misinterpretations of bodily sensations as indicative of serious illness (Asmundson et al., 2010; Asmundson, Taylor, & Cox, 2001; Lucock & Morley, 1996). It is considered a dimensional construct, ranging on a continuum from high to low (Asmundson et al., 2010; Ferguson, 2009). Low health anxiety does no harm and even plays a beneficial role in early diagnosis when severe illnesses do exist (Sirri & Fava, 2014). High health anxiety,[4] in which fears and beliefs that one has a serious illness persist or progress over

[4]In clinical settings, for diagnostic purposes, a cut-off point is defined to identify clinically significant health anxiety, which was formerly referred to as *hypochondriasis* (American Psychiatric Association, 2000). In the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-V) (American Psychiatric Association, 2013), hypochondria was replaced by two distinct disorders, somatic symptom disorder (SSD) and illness anxiety disorder (IAD). SSD is characterized by excessive and abnormal thoughts, feelings, and behaviors in response to disruptive and distressful somatic symptoms. IAD refers to the preoccupation of having or acquiring a severe illness with the presence of no or little somatic symptoms. It is estimated that about three quarters of hypochondria diagnosed under the DSM-IV-TR (4th Edition Text Revision) met the diagnostic criteria for SSD and one quarter for those of IAD (Bailer et al.,

time despite the absence of pathology, is less common and potentially harmful (Noyes, 2014).

2.1.2 Characteristics of health anxiety

People with health anxiety may demonstrate a series of affective and physiological characteristics to various degrees, depending on the severity of the condition. The affective characteristics include anxiety, depression, frustration, and anger. The physiological characteristics include sleep disturbance and changes in bodily functions (Warwick & Salkovskis, 1990). People with health anxiety also demonstrate a number of cognitive and behavioral characteristics, including catastrophic thinking, selective attention, bodily checking, avoidance, and reassurance (Salkovskis & Warwick, 2001; Taylor & Asmundson, 2004; Warwick & Salkovskis, 1989).

- Catastrophic thinking. Research has found that people with health anxiety tend to amplify physical sensations or interpret common symptoms as indicative of severe but unlikely illnesses (Hadjistavropoulos, Craig, & Hadjistavropoulos, 1998; Hitchcock & Mathews, 1992; Pauli, Schwenzer, Brody, Rau, & Birbaumer, 1993). Hadjistavropoulos, Craig, and Hadjistavropoulos (1998) found that people with high health anxiety perceived more pain severity and were more likely to describe the pain in affective terms than those with low health anxiety. Pauli et al. (1993) discovered that when attached with a pain stimulus, individuals with high health anxiety were

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2016). Note that the research subjects recruited for the present study are not limited to individuals with high health anxiety (those diagnosed with SSD or IAD), but include individuals with different levels of health anxiety, whether or not they meet the criteria for SSD or IAD.

more likely to be distracted in a concentration-performance test, even though the pain stimulus was never applied. Hitchcock and Mathews (1992) found that individuals with high health anxiety were more likely to interpret unfamiliar bodily signs as indicative of severe illness compared to those with low health anxiety. Such catastrophic interpretations of symptoms can, in turn, fuel anxieties about health.

- Selective attention. Individuals with health anxiety often have the tendency to attend to health-threat information and ignore evidence that indicates good health (Owens, Asmundson, Hadjistavropoulos, & Owens, 2004; Warwick & Salkovskis, 1990). Owens et al. (2004) administered a modified Stroop color-naming test, in which participants were asked to name the colors of ten pairs of illness-related and non-illness-related words presented on a computer screen. They found that individuals with high health anxiety took longer to name the color of illness-related words, indicating that they paid more attention to illness-related information. Similarly, Jasper, and Witthöft (2011) administered a visual dot-probe task (a test for examining attentional bias) with 16 pairs of illness-related and threat-neutral pictures presented on a computer screen. They found that people with high health anxiety spent a longer amount of time viewing illness-related pictures. Constant attention to illness-related information may reinforce the assumption of being sick, and lead to sustained anxiety.
- Bodily checking. Bodily checking is a common strategy for coping with unusual symptoms. People with high health anxiety often engage in repetitive, compulsive bodily checking, even in the absence of symptoms. Excessive bodily checking may increase the chances of noticing benign and harmless sensations, which are likely to

be misinterpreted by people with high health anxiety as signs of illnesses (Salkovskis & Warwick, 2001). Body palpating is a common form of bodily checking. Repeated palpating may cause irritations and heightened sensations. For instance, repeated swallowing or pressing the tongue to check for throat inflammation could induce soreness and the feeling of a lump in the throat, which may be misinterpreted as signs of infection or severe disease (Taylor & Asmundson, 2004).

- Avoidance. As a safety behavior, some people with health anxiety deliberately choose to avoid subjects or information that reminds them of, or confront them with, illness (Anu Sairanen, 2010; Barbour, Rintamaki, Ramsey, & Brashers, 2012). For example, people who are afraid of cancer may avoid medical screenings; those who suspect they may be contracting a certain disease may avoid searching for information about it. There are various rationales for avoidance, such as maintaining hope, avoiding overexposure to negative information, and not being able to manage potential risk (Anu Sairanen, 2010; Barbour et al., 2012). Avoidance may help with the short-term relief of anxiety but is likely to sustain long-term concerns (Warwick & Salkovskis, 1990), because the fear of disease is hidden but not eliminated; as a result, any intrusive stimuli encountered at a later time may reignite the fear.
- Reassurance seeking. In contrast to avoidance behavior, some people with health anxiety choose to actively seek relevant information for the purpose of reassurance (Lucock & Morley, 1996; Sirri & Fava, 2014; Warwick, 1989; Warwick & Salkovskis, 1990). People may seek reassurance from various sources, such as health providers, family and friends, and more commonly, the Internet. When practiced

appropriately, reassurance seeking is an effective coping strategy for reducing health-related fears and concerns. However, if performed excessively, it can perpetuate or even exacerbate health anxiety (Salkovskis & Warwick, 2001; Taylor & Asmundson, 2004; Warwick & Salkovskis, 1989).

2.1.3 Development of health anxiety

Although several theories have been proposed over time, the cognitive-behavioral model of health anxiety (Figure 2, adapted from Warwick & Salkovskis, 1990 and Salkovskis & Warwick, 2001) has remained dominant (Asmundson, Taylor, & Cox, 2001; Taylor & Asmundson, 2004; Warwick, 1989). It has been heavily cited and validated by many empirical studies (see Marcus, Gurley, Marchi, & Bauer, 2007 for a review). The cognitive-behavioral model illustrates the predisposing, precipitating, moderating, and perpetuating factors involved in the development and maintenance of health anxiety.

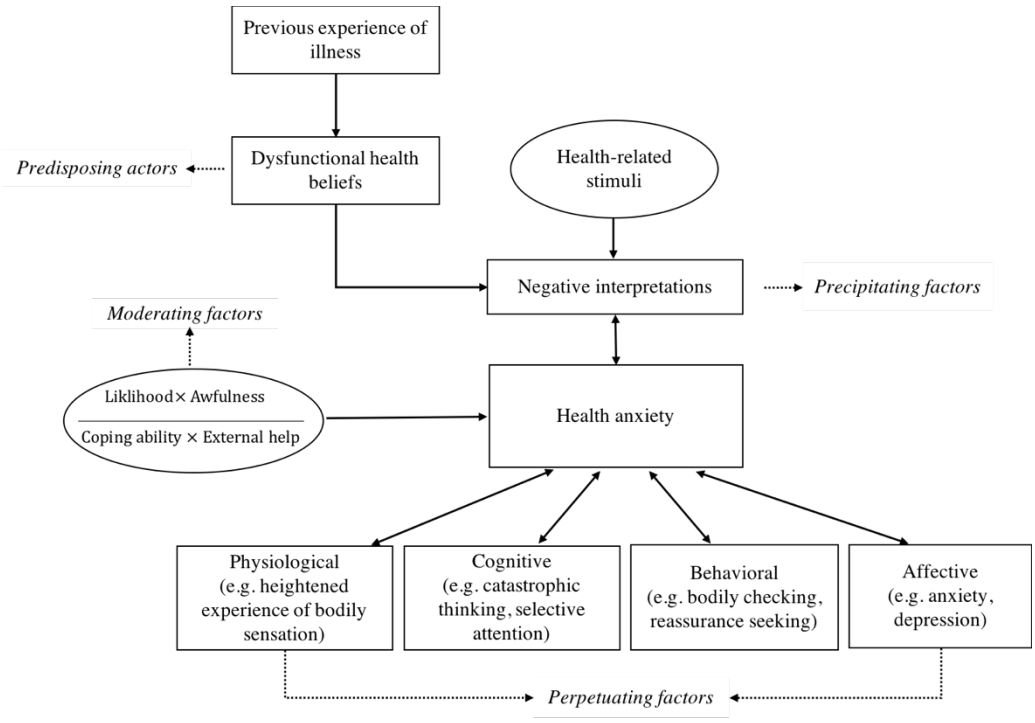


Figure 2: Cognitive-behavioral model of health anxiety (Salkovskis & Warwick, 2001; Warwick, 1989; Warwick & Salkovskis, 1990).

2.1.3.1 Predisposing factors

The cognitive-behavioral model suggests that dysfunctional beliefs, generally referred to as false or biased beliefs about health, are predisposing factors of health anxiety. People can develop dysfunctional beliefs over previous experiences of illness (Salkovskis & Warwick, 2001). For example, if someone experiences abnormal sensations without having them checked on time, and later falls seriously sick, he or she is likely to develop a belief that any unfamiliar physical sensation can be a sign of serious disease. Taylor and Asmundson (2004, p. 32) identified six types of dysfunctional beliefs: (1) beliefs about physical changes and sensations (e.g., "I'm healthy only when I

don't have any bodily sensations"); (2) beliefs about contracting disease and its consequences (e.g., "Serious diseases are everywhere"); (3) beliefs about vulnerability and self-efficacy (e.g., "My circulatory system is very sensitive"); (4) beliefs about doctors and medical evaluations (e.g., "Doctors can't be trusted because they often make mistakes"); (5) beliefs about reassurance (e.g., "Worrying about my health will keep me safe"); and (6) beliefs about death and the afterlife (e.g., "I'll be trapped and alone forever when I'm dead"). Individuals who hold such dysfunctional beliefs are prone to developing health anxiety (Salkovskis & Warwick, 2001), and the strength of the beliefs significantly correlates with the severity of health anxiety (Fergus, 2014a).

2.1.3.2 Precipitating factors

Dysfunctional beliefs do not work alone in the development of health anxiety, but mesh with certain health-related stimuli. A stimulus can be a bodily symptom (e.g., a persistent headache) or a critical life event (e.g., a disease outbreak). Influenced by intrusive health beliefs, people often have a tendency to misinterpret a health-related stimulus as a serious threat to their health (Weck, Neng, Richtberg, & Stangier, 2012). For example, a person who believes he or she is highly susceptible to cancer is likely to misinterpret a persistent headache as indicative of a brain tumor. Such a negative interpretation of a health concern is the central mechanism of health anxiety (Salkovskis & Warwick, 2001).

2.3.1.3 Moderating factors

The intensity of health anxiety is determined by the perceived (a) likelihood of having a health problem, (b) severity of the problem, (c) ability to cope with the problem, and (d) amount of external help available for managing the problem. Intense health anxiety is likely to develop when high likelihood and severity interweave with inadequate coping ability and a lack of external help (Salkovskis & Warwick, 2001).

2.1.3.4 Perpetuating factors

As discussed in Section 2.1.2, health anxiety is associated with a series of physiological (e.g., a heightened experience of bodily sensations), affective (e.g., anxiety and depression), cognitive (e.g., selective attention and catastrophic thinking) and behavioral (e.g., bodily checking and reassurance seeking) characteristics. The cognitive-behavioral model suggests that these characteristics not only occur as a consequences of health anxiety, but also serve as maintaining factors (Salkovskis & Warwick, 2001). First, catastrophic thinking and selective attention can perpetuate or intensify health anxiety. Individuals with high health anxiety are susceptible to catastrophic interpretations of benign symptoms or health information as indications of serious illness. Their presumption of illness leads them to selectively attend to information that appears to confirm the presence of severe illness, and to discount information pointing to a lesser diagnosis. Selective attention can not only reinforce the idea that one has a severe illness, but can also increase one's chances of encountering new anxiety-evoking stimuli, and thus lead to persistent, or even advanced, health anxiety.

Second, negative affect and consequential physiological sensations can perpetuate or intensify health anxiety. The affective experience of heightened anxiety or fear resulting from catastrophic interpretations of health information is often accompanied by a heightened experience of physiological sensations such as increased heart rate and blood pressure. Increased bodily sensations may be then misinterpreted as further evidence of illness, and thus fuel the affective experience of anxiety. Health anxiety is maintained through a spiraling interaction of misinterpreted symptoms or health information, increased bodily sensations, and the affective experience of anxiety or fear.

Third, excessive safety-seeking behaviors can perpetuate or worsen health anxiety. To cope with increased anxiety or fear, people are motivated to perform safety-seeking behaviors, such as self-checking concerned areas for signs of inflammation and seeking reassurance. However, as discussed in Section 2.1.2, for people with high health anxiety, repeated bodily checking and palpating may increase the chance of detecting bodily variations and thus confirm the assumption of illness.

Reassurance seeking, as Salkovskis and Warwick (2001) noted, is a more troublesome safety-seeking behavior when practiced disproportionately. Every now and then, people (even those with low or no health anxiety) may feel concerned about their health, especially when they notice unusual symptoms. Such transient health-related concerns often decline or disappear following appropriate medical evaluation and reassurance. However, for people with high health anxiety, reassurance seeking may have an ironic effect. First, people who repeatedly seek reassurance may prolong their exposure to illness-focused conversation. Constant attention on an illness of concern may

reinforce the assumption that one is sick, causing heightened health anxiety. Second, excessive medical examinations could potentially send an alarming signal to people who are already concerned about their health. Moreover, when reassurance ends with ambiguous or conflicting results, it almost undoubtedly will intensify concerns (Salkovskis & Warwick, 2001; Taylor & Asmundson, 2004). An increase in health concerns, in turn, might lead to further reassurance seeking, so that a vicious cycle is established.

2.1.4 Summary

The cognitive-behavioral model explains the origins and development of health anxiety, and highlights a number of physiological, affective, cognitive, and behavioral characteristics of health anxiety, which often act as maintaining factors. One major assumption of this model is that people with health anxiety tend to form catastrophic interpretations of illness-related information, and as a result, develop extensive fear and anxiety about their health. To cope with negative affect, people with high health anxiety may persistently seek reassurance but end up feeling even more worried. Since the model was developed prior to the Internet Age, the main forms of reassurance seeking discussed in this model are consulting healthcare providers and/or taking medical tests, and thus little discussion has taken place on the relationships between health anxiety and OHIS. Nevertheless, the main assumptions of the cognitive-behavioral model still have important theoretical implications for research on the relationships between health anxiety and OHIS. This is because the major characteristics of health anxiety specified in

this model, such as catastrophic interpretations of illness-related information, selective attention, and repeated information seeking are also likely to occur during OHIS. In fact, a limited number of studies have just begun to look into the relationships between health anxiety and OHIS under the guidance of the cognitive-behavioral model. Details of these studies will be discussed after the review of the OHIS literature in Section 2.2.

2.2 ONLINE HEALTH INFORMATION SEEKING (OHIS)

2.2.1 Defining information seeking and OHIS

Information seeking, as Case (2012) claimed is a "taken-for-granted" concept whose meaning seems counterintuitive. Although information seeking lacks a consensus definition, one commonality attributed to it by many scholars is that it is a purposive, goal-oriented process. As defined by Wilson (2000, p. 49), *information seeking* is "the purposive seeking for information as a consequence of a need to satisfy some goal." The purposive characteristic distinguishes information seeking from passive information behavior, such as *information encountering* which is the "accidental discovery of useful or interesting information" (Erdelez, 1997, p. 412).

There is no apparent definition of *OHIS*. The word *health* simply implies the type of information sought (Lambert & Loiselle, 2007) and *online* indicates the channel or context where information seeking is conducted. Thus, considering the definition of information seeking, *OHIS* could be defined as the purposive acquisition of information from the Internet for health-related purposes. *Health*, as defined by the World Health

Organization, is "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 1984). To be specific, Xie, Wang, and Feldman (2011) categorized seven types of health information: diagnosis, treatment, laboratory test, self-care (including healthy lifestyle), complementary/alternative medicine, psychosocial, and health care provider. This dissertation focuses on health information seeking for diagnostic purposes, as the diagnosis of a specific disease or medical problem is the goal of most popular health searches (Fox & Purcell, 2010), which are more likely to trigger anxiety about health.

2.2.2 Models of information seeking

Many information seeking models have been developed over the past decades. These models focus on various aspects of information seeking, including antecedents or motivational factors (e.g., Byström & Järvelin, 1995), process (e.g., Ellis, 1989), style (e.g., Longo, 2005), and channels of information seeking (e.g., Johnson, 1995). These models also vary in terms of their context of development: whether they were developed specifically for the health context, whether they were developed for a physical or digital environment, and whether they target specific or ordinary users.

As the goal of the present study is to investigate the relationships between health anxiety and the cognitive, affective, and behavioral aspects of OHIS, a model that would be helpful for guiding the current research should involve all three dimensions of information seeking. However, models of information seeking have predominantly focused on the cognitive dimension, rarely including affect as a major dimension. Despite

some early efforts to advocate for the role of affect in information seeking[5], "affect as a lens for understanding information behavior has always lurked predominantly in the field's theoretical shadows" (Fisher & Landry, 2007, p. 211). An exhaustive review of the literature identified three models in the information science literature that sufficiently address affect as a main dimension of information seeking: Carol Kuhlthau's Information Search Process Model, Diane Nahl's Social-Biological Information Technology Model, and Robert Griffin's Risk Information Seeking and Processing Model. The rest of this section provides a comprehensive review of these models.

2.2.2.1 The Information Search Process (ISP) Model

Carol Kuhlthau is among the first scholars in information science to investigate the affective dimension of information seeking. The ISP model is developed based on a diversity of theories and models in psychology and information science, and has been validated by a number of empirical research studies (Kuhlthau, 1991; Kuhlthau, 2004). As Kuhlthau claimed, "A model representing the user's sense-making process of information seeking ought to incorporate three realms of activity: physical, actual actions taken; affective, feelings experienced; and cognitive, thoughts concerning both process and content. A person moves from the initial state of information need to the goal state of

[5]Thomas D. Wilson and Brenda Dervin are among the forerunners who advocated the role of human affect in information seeking. Wilson's model embedded stress/coping theory as an activating mechanism of information seeking, although little explanation is given as to how stress and coping function in relation to information seeking (Wilson, 1999). Dervin called on researchers to "bring emotions out of the closet" (Dervin, 1983, p. 42). She stressed that "sense making (theory) mandates attention not only to the material embodiment of knowing, but to the emotional/feeling framings of knowing as well" (p. 42). She claimed three ways in which affect intertwines with information behavior, which reflect the double role of emotion: First, she considered emotions as a major outcome of information seeking; her second and third views emphasized the manipulative role of emotions in information seeking and processing.

resolution by a series of choices made through a complex interplay within these three realms" (Kuhlthau, 1991, p. 362).

Kuthlthau's model demonstrates how people's affective, cognitive, and behavioral activities may change through six stages of information seeking (Figure 3, adapted from Kuhlthau, 1991): initiation, selection, exploration, formulation, collection, and presentation. In the affective dimension, users start off with somewhat negative feelings (e.g., uncertainty) and gradually transition to more positive ones (e.g., optimism and confidence) towards the end of the search. In the cognitive dimension, users begin with vague ideas about their information needs, and these gradually grow into a more focused information goal. In the behavioral dimension, users move from exploring information broadly to collecting and documenting pertinent information.

Kuthlthau's model illustrates the features of the cognitive, affective, and behavioral processes during information seeking, but the diagram itself does not specify the nature of their relationships. However, in her discourse, Kuhlthau did explain the associative relationships between the cognitive and affective dimensions (but not much about the behavioral dimension): "The affective symptoms of uncertainty, confusion and frustration are associated with vague, unclear thoughts about a topic or question. As knowledge states shift to more clearly focused thoughts, a parallel shift occurs in feelings of increased confidence."

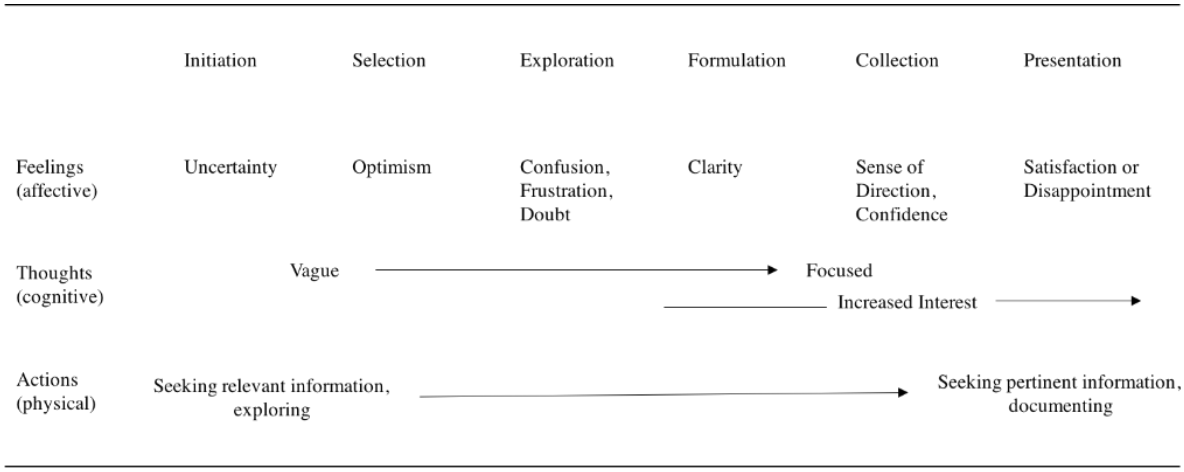


Figure 3: Information Search Process Model.

2.2.2.2 The Social-Biological Information Technology Model (SBIT)

Diane Nahl was inspired by what she coined an "affective revolution," which was initiated in psychology and cognitive science in the early 1990s and has gradually expanded its influence to information science. The central idea of the affective revolution is recognition of the dual role of affect, both as a responsive mechanism of cognitive evaluation and a regulatory system of subsequent behavior. Unlike Kulhthau's model, which was built upon research on information seeking in physical libraries, Nahl's model was grounded in research on information seeking in digital environments (Nahl, 2007b).

Nahl stresses that a comprehensive information seeking model should integrate three intersecting dimensions of the information environment: (a) the human biological system, which enables information seeking and processing; the complete biological

system functions under the interplay of sensorimotor,[6] cognitive, and affective subsystems; (b) information technologies, which provide affordances[7] to facilitate information seeking; and (c) social practices, which are social norms and values that guide information seeking. The relationship of the three dimensions is described as follows: "Information behavior is directed by social communication practices, operates through individual biological procedures, and interacts with technological information devices" (Nahl, 2007b, p. 2023). The following discussion focuses on the biological dimension, as it is most relevant to the present study.

Nahl's SBIT Model (Figure 4, adapted from Nahl, 2007b) depicts information seeking as an iterative process of two basic practices: information reception and information use. Both require a combined effort of human sensorimotor, cognitive, and affective systems. *Information reception* starts with noticing information (sensorimotor), then proceeds to appraising information (cognitive), which simultaneously triggers certain feelings (affective). Following information reception, *information use* is the process during which users optimize the value of the received information by making use of it. For instance, users may use the information they found to inform further searching; in this sense, information use is actually equivalent to the process of information searching. It starts with what Nahl called "affective intentionality" namely, feeling the

[6]Nahl adopted the term "sensorimotor" from ergonomics. She explained that when used in the information-seeking context, the sensorimotor system functions by "sensing, filtering, and noticing information displays" and by "handling or operating input devices" (e.g., mouse clicking, scrolling, keystrokes). She referred to these sensorimotor activities as "microinformation behaviors" (Nahl, 2007b, p. 2023).

[7]The term "affordance" originally came from the psychology literature and later was widely used in the human-computer-interaction literature. *Affordances* are the properties of a subject that enable the user to perform certain actions (Gaver, 1991), for example, a keyboard for typing a search query, a mouse for selecting a link, and a monitor for text reading.

urge to search (affective), then proceeding to search planning (cognitive), which is executed through the performance of certain search actions (sensorimotor). Following these search actions (e.g., clicking a link or typing a search query), searchers land on a new page of information, where another round of the information reception process is carried out. The iterative process between information reception and information searching continues until the searcher decides to terminate the search. The six affective, cognitive, and sensorimotor activities (i.e., noticing, appraising, and evaluating during information reception, and intending, planning, and performing during information search) have been repeatedly identified in numerous empirical studies (Nahl, 2005a, 2005b, 2007a, 2007b).[8]

[8]Nahl did mention that not all activities included in the model were identified in any single case of analysis. For example, a user may simply notice something without processing it, or a user may notice and evaluate the information but decide not to use it in any way.

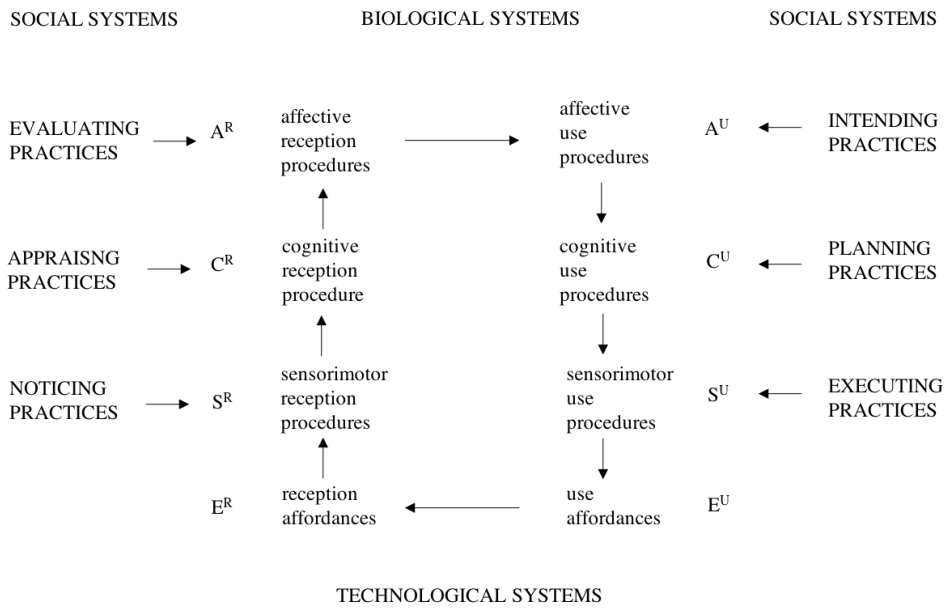


Figure 4: Socio-Biological Information Technology Model.

In describing the process of information seeking, Nahl's model distinguishes itself from Kuhlthau's ISP model in at least two ways: First, Kuhlthau's model depicts information seeking as a one-directional linear process, whereas Nahl's model considers information seeking as an iterative process between information reception and information searching. Iteration has been widely recognized as an important feature of information seeking in digital environments (Xie, 2008); in this sense, Nahl's SBIT Model is more compatible with the present study, which focuses on online information seeking. Second, as discussed earlier, Kuhlthau's model does not specify the relationships among the affective, cognitive, and behavioral dimensions, while Nahl's model clearly illustrates the interactions among the three dimensions, with particular emphasis on the dual role of affect — on one hand, affect is responsive to the cognitive appraisal of

incoming information; on the other hand, affect initiates and guides search planning and search actions.

2.2.2.3 The Risk Information Seeking and Processing Model (RISP)

Griffin's RISP model was largely drawn from the Theory of Planned Behavior (Eagly & Chaiken, 1993) and the Heuristic-Systematic Model of Information Processing (Ajzen, 1988). Unlike Kulthaul's and Nalh's models, which focus on the "during search" stage of information seeking, the RISP Model focuses on the "prior to search" stage of information seeking. Griffin, Dunwoody and Neuwirth (1999) proposed the RISP model in an attempt to explore the antecedent factors influencing the intention and style of information seeking in risk-involving contexts.

The model (Figure 5, adapted from Griffin, Dunwoody & Neuwirth, 1999) was constructed under the assumption that under some circumstances, information seeking is a risk-management strategy. Assessments of perceived risk can cause a positive or negative affect, and the characteristics of the affect influence perceptions of information sufficiency, which eventually influences the intention and style of information seeking. Like Nahl's SBIT Model, Griffin's model also suggests the dual role of affect: on one hand, it is responsive to cognitive perceptions of risk; and on the other, it influences perceptions of information sufficiency and subsequent search behavior.

Griffin, Dunwoody and Neuwirth (1999) laid out four basic styles of information seeking: (a) routinized-heuristic, in which individuals follow their habitual strategy for obtaining information and process information heuristically without much critical and

constructive thinking; (b) routine-systematic, in which individuals obtain information according to habit but process it more deeply and critically; (c) nonroutine-heuristic, in which individuals go beyond their comfort zone to gather information but process the information heuristically; and (d) nonroutine-systematic, in which people actively and laboriously engage in information seeking from a variety of sources and process the information in a constructive way. While testing this model, Griffin et al. (2008) used simple scale questions to measure styles of information seeking (e.g., "When it comes to the topic of …, I'm likely to go out of my way to get more information") and found that a more intense affect (he focused on one specific type of affect, anger) appeared to produce more laborious information seeking behavior, indicating a positive associative relationship between affect and search behavior. One limitation of this study is that the measures of search behavior relied solely on subjective responses to general questions and did not include objective metrics or variables relating to search behaviors in order to complement the subjective responses.

What makes the RISP Model especially useful for the present study is that it introduces risk perception as a main component of the cognitive dimension of risk-involved information seeking. Griffin et al. (2008) proposed four variables to account for variances in individuals' perceptions of risk: (1) the likelihood of harm to self or others, (2) the severity of the harm, (3) personal efficacy and (4) institutional trust (e.g., trust in health providers). Health information seeking is a risk-involved process, as the information sought is directly relevant to someone's health, and in some circumstances, having the right information can be a matter of life or death. The risk nature of health

information seeking makes the model a good fit for the present study. In fact, the RISP Model has already been tested in the health context (Kahlor, 2010). Furthermore, risk perception associated with health-related issues is also closely relevant to health anxiety – the other major concept of the present study. As discussed in Section 2.1.2, individuals with health anxiety are more likely to have catastrophic interpretations of bodily symptoms and health-related information (Asmundson, Taylor, & Cox, 2001), which presumably means that they are more likely to perceive a higher risk in regard to a specific medical condition than those with low health anxiety.

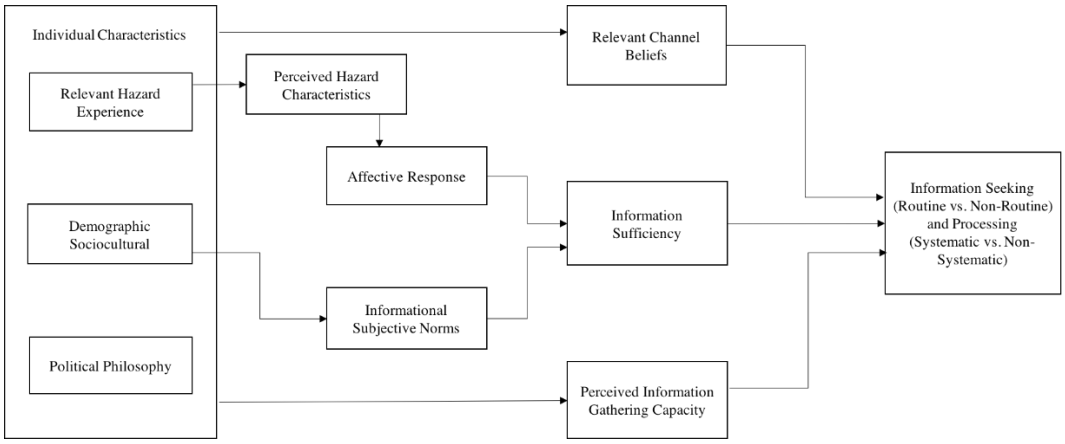


Figure 5: Risk Information Seeking and Processing Model (RISP).

2.2.3 Health-related Internet use

In the last two decades, the popularity of the Internet and the diffusion of personal computers and mobile devices have made health information more accessible and affordable than ever. For many people, the Internet has quickly become one of the most commonly used health information channels (Marrie, Salter, Tyry, Fox, & Cutter, 2013).

In the U.S., 72% of Internet users and 62% of smartphone owners have gone online to look for health information (Fox & Duggan, 2013; Smith et al., 2015).

The Internet has four outstanding benefits compared to traditional information channels (e.g., mass media and health professionals). First, it contains a rich amount and variety of health information. Authoritative resources on the Internet (e.g., MedlinePlus.gov) provide people with good quality health information, which at one time was solely possessed by health professionals. Second, health information on the Internet is easily accessible at little or no cost. Accessibility is a key reason that people choose the Internet as their favored health information channel (Zhang, 2014). With the boom in portable and wearable devices, people can access health information almost anywhere and anytime. Numerous health apps allow people to track and manage their health in the palm of their hand. Third, health information on the Internet can be tailored to match personal interests, due to the power of search engines. Advanced eHealth technologies (e.g., MedlinePlus Connect) can even connect electronic patient records with authoritative health websites and automatically retrieve and deliver customized health information to patients (Burgess, Dennis, Lanka, Miller, & Potvin, 2012). Fourth, with the prevalence of social media, one's social network has been extended from the physical world into virtual communities, where people worldwide can share common health interests and exchange health advice and emotional support (Moorhead et al., 2013).

However, the Internet is not a guaranteed solution for health information needs. First, the quality and credibility of online health information has always been of great concern to both consumers and health professionals. Zhang, Sun, and Xie (2015)

conducted a systematic literature review of 165 studies that evaluate the quality of consumer-oriented health information websites. They found that 55% of the studies reported the overall quality of the evaluated sites as problematic (e.g., having incorrect or incomplete information). Lawrentschuk et al. (2011) examined 150 oncological health websites and found 70% of the websites were not accredited by the HON (Health on the Net Foundation, 2014) code. Buhi et al. (2010) found that although the majority of information on 177 sexual health websites was accurate, information on controversial topics (e.g., abortion) and complex problems (e.g., contraception) still contained inaccuracies. Large amounts of information posted on social media are generated by unidentifiable consumers, and thus, the reliability of the information is difficult to discern (Moorhead et al., 2013). Although the problem of quality is not exclusive to information on the Internet, the large quantity of unauthorized information, combined with easy access, creates quicker links and more extensive exposure to problematic information than conventional information channels.

Second, the way that many people search and appraise online health information is even more worrisome. Many studies (e.g., Rios, 2013; Stellefson et al., 2011) have shown that the general public in the U.S., especially underserved populations, have insufficient eHealth literacy.[9] A survey study found that one in three Americans were "online diagnosers," among whom only 41% confirmed their diagnosis with a medical professional; others either never consulted medical professionals, or their diagnoses were

[9]eHealth literacy is defined as "the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem" (Norman & Skinner, 2006).

deemed incorrect (Fox & Duggan, 2013). The majority of online health seekers start their searches using a search engine (Fox & Duggan, 2013) and most choose only from the top-ranking results (Eysenbach & Kohler, 2002; Kim, Park, & Bozeman, 2011). Some users may not even realize that the ranking of search engine results is based on website popularity and content relevance, and does not necessarily correlate with website quality (White & Horvitz, 2009b). Even people who may, to some degree, know how to assess the quality of information, often might not spend time doing so (Eysenbach & Kohler, 2002; Kim & Sin, 2011). As people's preference for quick access overrides their concerns about information quality, the chances that they will encounter poor-quality information is likely to increase.

Moreover, modern search engines, even the most prestigious ones, are still limited in terms of health information retrieval, especially when used for diagnostic purposes. In reality, doctors making diagnostic decisions rely not only on patients' descriptions of their symptoms, but also on their health histories, daily activities, physical signs, and so forth. However, search engines can only "make a decision" based on information relevance, looking for a match between a query and webpage content at the semantic level, not necessarily at a pathological level, as a real doctor would do. For example, at the semantic level, lack of sleep and brain tumors are both associated with headaches; however, at the pathological level, in most cases, a headache is more likely to be caused by lack of sleep than a brain tumor. In fact, the rate at which search engines return disastrous information based on searches regarding benign symptoms is surprisingly high. For example, White and Horvitz (2009a) found that there was a 26% of chance that

searching for "headache" using general search engines would yield information about brain tumors. However, in fact, the risk of having brain tumor for patients with primary headache is as low as 0.045% (Kernick, Stapley, Goadsby, & Hamilton, 2008). While having adequate health information may help users manage uncertainty and eliminate health concerns, too much information, especially threatening and misleading information, can evoke anxiety and lead to negative consequences.

2.3 THE RELATIONSHIP BETWEEN HEALTH ANXIETY AND OHIS

As discussed in the previous section, compared to traditional channels of health information (e.g., health providers), the Internet provides much quicker and easier access to an immense amount of health information for those who are agitatedly seeking reassurance for immediate relief of anxiety. Recent studies have suggested that there are links between health anxiety and the affective, cognitive, and behavioral dimensions of OHIS.

2.3.1 The relationship between health anxiety and the cognitive dimension of OHIS

The cognitive dimension of OHIS may involve a variety of activities, ranging from identifying an information goal (what to search for) to formulating a search strategy (where to search and how to search), to evaluating the information retrieved. Studies investigating the relationship between health anxiety and the cognitive aspect of OHIS focus mainly on perceptions of information quality, the types of health information sought online, and preferences for information sources. Singh and Brown (2014) found

that health anxiety was correlated more with searching for illness-related information (e.g., information about specific diseases) than searching for wellness-related information (e.g., information about exercise and diet). Muse, McManus, Leung, Meghreblian and Williams (2012) found that individuals with high health anxiety sought more types of health information. They were more interested in information on diagnosed and undiagnosed medical conditions and in descriptions of other people's experiences with illness. They also found that individuals with high health anxiety were significantly more likely to select message boards and/or support groups as health information sources. This indicates that people with health anxiety may prefer consumer-generated content. In developing the Cyberchondria Severity Scale, McElroy and Shevlin (2014) found that the item "I visit trustworthy sources when researching symptoms or perceived medical conditions online" registered a much smaller weight than the item "When researching symptoms or medical conditions online, I visit forums where diagnosed or concerned individuals discuss their medical conditions, symptoms and experiences." This also suggests that people with high health anxiety may have a preference on consumer health forums rather than trusted sources such as government websites.

In Baumgartner and Hartmann (2011), researchers randomly assigned participants to two mockup websites (a government website ending in the suffix .gov and a health forum website ending in .com) and asked them to read the same text describing a fictitious disease. They found that individuals with higher health anxiety felt they had a greater likelihood of contracting the disease. However, such differences were only significant for the group who read the text from the government website. This suggests

that the source of information may have a moderating effect on the relationship between health anxiety and interpretations of disease-related information.

2.3.2 The relationship between health anxiety and the affective dimension of OHIS

As the cognitive-behavioral model suggests, people with high health anxiety are more likely to experience a negative affect after reassurance seeking (Salkovskis & Warwick, 2001). Evidence supports such a link between health anxiety and negative affect following OHIS. In an interview study (McManus, Leung, Muse, & Williams, 2014), participants (individuals with high health anxiety) reported that OHIS frequently exposed them to unexpected or unfamiliar diseases which they subsequently became worried about. Exacerbated concerns in turn drove them to search more information. One participant described this as a "worry cycle," in which one search led to another driven by, and resulting in, escalated worries (p. 9). They also mentioned that although sometimes OHIS made them feel relived, such relief was often short-lived. Similar comments were noted in another interview study (Singh, Fox, & Brown, 2016).

In Baumgartner and Hartmann (2011), researchers examined the relationships between health anxiety and four negative affects (feelings of being overwhelmed, confused, frustrated and frightened) and two positive ones (feelings of being relieved and reassured). The results show that health anxiety was positively associated with all four negative affects, but was not associated with either of the two positive ones. Muse et al. (2012) found that people with high health anxiety felt more distressed and anxious about their health after searching for health-related information online. As part of his

dissertation research, Singh (2014) developed a scale for measuring health-related Internet use, referred as the Online Health-Related Beliefs and Behaviors Inventory. One of the subscales which measures post-search negative affect (e.g., worry and anxiety) was found to be positively correlated with health anxiety. Similarly, Doherty-Torstrick, Walton, and Fallon (2016) found that health anxiety was a significant predictor of post-search distress.

2.3.3 The relationship between health anxiety and the behavioral dimension of OHIS

As discussed above, the cognitive-behavioral model suggests that people with high health anxiety often engage in excessive reassurance seeking (Salkovskis & Warwick, 2001). Guided by the cognitive-behavioral model of health anxiety, some scholars have proposed a similar hypothesis, that in addition to repeated reassurance seeking from healthcare providers, people with health anxiety are also likely to perform excessive OHIS. Muse et al., (2012) found in a survey study that health anxiety was positively correlated with OHIS frequency and duration. Baumgartner and Hartmann (2011), and te Poel, Baumgartner, Hartmann and Tanis (2016) found that health anxiety was strongly associated with the frequency of searching for and posting health-related information online. Singh and Brown (2014) found that individuals with higher health anxiety reported a greater proportion of health-related Internet use in relation to their non-health-related Internet use. Singh and Brown (2016) found that individuals with high health anxiety, compared to those with low health anxiety, were more likely to perform

escalated searches (searches that start with a common symptom but follow with a subsequent search involving a serious medical condition, either by entering a new search query or by clicking on a link).

2.3.4 Gaps in the literature

Studies on relationships between health anxiety and OHIS share some common methodological and theoretical limitations.

First, to study the relationship between health anxiety and the affective aspect of OHIS, most studies relied solely on participants' self-recall of their affective experiences during OHIS, without having them engage in actual search activity. As Robinson & Clore (2002) suggested, the validity of self-reported affective states depends, to a high degree, on the time and context of the report. Data collected during or immediately after experiencing an event is likely to be more valid than those collected about an experience somewhat distant in time. This is because human affect may fluctuate constantly depending on the environment, and subjects' recall of earlier experiences may be colored by their current affective states. To compensate for such limitations, both Doherty-Torstrick et al. (2016) and te Poel et al. (2016) have suggested conducting observational research to capture real-time data.

Second, research on the relationship between health anxiety and OHIS has been led predominately by psychology researchers, but has rarely been investigated from the viewpoint of information science, despite the fact that OHIS is a major theme in the discipline. Consequently, these studies share a common limitation, namely, that when

examining the relationship between health anxiety and OHIS, most studies measured, via recollective survey, only one or two general variables regarding search behavior, such as the frequency and duration of searches. No one has conducted experiment research to investigate how health anxiety may impact the actual search process. Fortunately, research in information science provides a sufficient range of variables for evaluating the different aspects of a search process, such as query formulation, navigation path, search effort, search efficiency, search outcome, and so forth. These behavioral variables are usually studied by analyzing search logs and/or screen activities in lab settings. Looking into the actual search process will help us identify patterns in the search behaviors of health-anxious individuals that may explain why people with health anxiety are more likely to experience negative affect following OHIS.

Third, the studies reviewed have treated the cognitive, behavioral, and affective dimensions of OHIS as three independent, unrelated entities: Some examined the relationship between health anxiety and the behavioral dimension of OHIS (e.g., search frequency and duration); some studied the relationship between health anxiety and the affective dimension of OHIS; and some investigated the relationship between health anxiety and the cognitive dimension of OHIS (e.g., perceived quality of online health information). However, few have looked simultaneously into the relationships between health anxiety and the three dimensions of OHIS in one study. The ISP model, the SBIT model, and the RISP model, reviewed in Chapter 2, all suggest that the cognitive, affective, and behavioral dimension are three inter-connected components of information seeking. Investigating only one component is unable to provide a holistic view of the

relationships between health anxiety and OHIS. Future research should consider investigating the relationships between health anxiety and all three dimensions of OHIS in order to achieve a better understanding of OHIS and of how health anxiety may impact each of the dimensions.

Chapter 3: Conceptual Framework and Research Hypothesis

The conceptual framework for the present study was established based on relevant theories, models, and empirical research discussed in Chapter 2, particularly the cognitive-behavioral model of health anxiety, the ISP model, the SBIT model, and the RISP model. This framework, the eHealth Anxiety Model (eHAM), illustrates the relationship between health anxiety and OHIS (Figure 6). The framework consists of three aspects of OHIS: cognitive, affective and behavioral. In the center of the framework is health anxiety, which is associated with the cognitive, affective and behavioral aspects of OHIS. The rest of this section discusses the relationships between health anxiety and these aspects of OHIS.

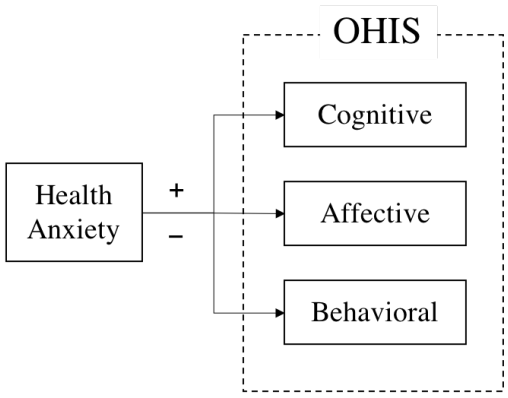


Figure 6: The eHealth Anxiety Model (eHAM).

3.1 THE COGNITIVE DIMENSION OF OHIS AND ITS RELATIONSHIP TO HEALTH ANXIETY

The present study focuses on an important cognitive variable that is particularly relevant to health anxiety and OHIS — perceived health risk. *Risk* is defined as "the possibility that human actions or events lead to consequences that harm aspects of things that human beings value" (Klinke & Renn, 2002, p. 1071). *Perceived health risk* is the judgment that people make about the extent to which their health is at risk under certain circumstances, such as when they experience certain bodily symptoms or are exposed to certain health-related information. In the present study, *perceived health risk* refers to participants' perceptions about a given case of illness based on which they performed an online search to find the correct diagnosis. Guided by the RISP model (Griffin, Dunwoody & Neuwirth, 1999), perceived health risk can be assessed based on four aspects: (1) the perceived susceptibility to contracting the illness, (2) the perceived severity of the illness, (3) the perceived self-efficacy in coping with the illness, and (4) the perceived trust in health-professionals to take care of the illness.

According to the cognitive-behavioral model (Salkovskis & Warwick, 2001; Warwick, 1989), health risk perception is closely related to health anxiety. As the model suggests, people with high health anxiety tend to have catastrophic interpretations of bodily symptoms or illness-related information, and thus, are likely to perceive greater health risks. Barsky, Ettner, Horsky and Bates (2001) found that people with high health anxiety believed they had a greater susceptibility to various medical diseases than those with low health anxiety. Similarly, Hadjistavropoulos, Craig and Hadjistavropoulos

(1998) found that health-anxious individuals believed themselves to be at greater risk of experiencing medical complications than non-health-anxious individuals. Baumgartner and Hartmann (2011) found that when reading the same information of a fictitious disease on a webpage, people with higher health anxiety perceived greater likelihood of contracting the disease in the future. Singh, Fox and Brown (2016) found that searching for health information online could potentially expose people to alarming information that is likely to induce negative thoughts about health. Based on the existing research evidence, the following research hypothesis are proposed:

H1a: OHIS leads to greater increases in perceived health risks among individuals with higher health anxiety than among those with lower high anxiety.

H1b: Health anxiety is positively associated with perceived health risk.

3.2 THE AFFECTIVE DIMENSION OF OHIS AND ITS RELATIONSHIP TO HEALTH ANXIETY

The three models of OHIS discussed in Chapter 2, although they recognize the role of affect in OHIS, they do not specify how affect should be conceptualized. Fortunately, much of the literature in psychology has proposed various approaches to conceptualizing affect, two of which are the discrete approach and the dimensional approach. The *discrete approach* holds that affect consists of a list of distinct manifestations that are universally identifiable (Ekman & Cordaro, 2011). The discrete approach is particularly useful when the goal of the research is to understand whether or not a certain stimulus is associated with one or more specific affects. Some research on information seeking has adopted this approach to study basic affects individuals

experience during the information seeking process (Arapakis, Konstas, & Jose, 2009; Gonzalez-Ibanez, 2013; Lopatovska, 2009).

The *dimensional approach* suggests that affect should be conceptualized in terms of dimensions. For example, James Russell's Core Affect Theory suggests that affect should be evaluated in terms of two basic dimensions: valence and arousal (Russell, 2003). *Valence* refers to the tone of affect, ranging from extremely positive, through neutral, to extremely negative. *Arousal* refers to the state of activation, ranging from completely calm, through various degrees of activation, to completely aroused. In addition, Bradley and Lang (1994) suggested a third dimension, namely, *control*. This dimension is the extent to which people feel in control of a situation, ranging from the feeling of being controlled to being in control. Some research on information seeking has adopted the dimensional approach to study the affective aspect of information seeking (e.g., Arapakis, Jose, & Gray, 2008; Gonzalez-Ibanez, 2013). The current study will use the dimensional approach because the interest of the study does not focus on any specific type of affect, but rather on affect in general.

Both the cognitive-behavioral model (Salkovskis & Warwick, 2001) and many empirical studies, as discussed in Section 2.3.2 (Baumgartner & Hartmann, 2011; Doherty-Torstrick et al., 2016; McManus et al., 2014; Muse et al., 2012; Singh, 2014), have suggested that individuals with high health anxiety are more likely to experience negative valence, following OHIS. Therefore, I hypothesize:

H2a: OHIS leads to greater increase in negative affect among individuals with higher health anxiety than among those with lower health anxiety.

H2b: Health anxiety is positively associated with negative valence.

Searching health information online could potentially expose people to alarming information that is likely to induce negative thoughts about health (Singh, Fox & Brown, 2016). And the cognitive-behavioral model also suggests that people with higher health anxiety tend to experience higher arousal as a result of catastrophic thinking of the symptoms (Warwick, 1989). Therefore, it is hypothesized that:

H3a: OHIS leads to greater increase in arousal among individuals with higher health anxiety than among those with lower health anxiety.

H3b: Health anxiety is positively associated with arousal.

To my best knowledge, no prior research has directly examined the relationship between health anxiety and sense of control in the context of OHIS. However, some preliminary evidence exists in the literature suggesting such a relationship. For example, Marcus et al., (2007) found that individuals with high health anxiety perceive themselves to possess less control over the disease. Eastin and Guinsler (2006) found that health anxiety is associated with higher number of doctor visits following OHIS, which may also indicate less self-control of their health. Singh, Fox and Brown (2016) found that participants with high health anxiety felt a lack of control when encountering information that was "inconclusive, conflicting and indicative of serious illness". Based on existing research evidence, the following hypotheses are proposed:

H4a: OHIS lead to greater decrease of sense of control among individuals with higher health anxiety than among those with lower health anxiety.

H4b: Health anxiety is negatively associated with sense of control.

3.3 THE BEHAVIORAL DIMENSION OF OHIS AND ITS RELATIONSHIP TO HEALTH ANXIETY

In the information science literature, search behavior has been studied both as a process and as an end-of-search result. When studied as a process, *search behavior* refers to the series of actions that searchers take during a search process, such as mouse clicks and keystrokes (Lopatovska, 2009). When studied as an end-of-search result, it refers to searchers' cumulative performance (Gonzalez-Ibañez & Shah, 2015; Gwizdka, 2010; Lopatovska, 2014). The present study aimed to examine search behavior as both a process and an end-of-search outcome, as measured by two specific variables: *search effort* as a measure of the process, and *search accuracy* as a measure of end-of-search outcomes. *Search effort* refers to the depth and scope of a search, which is often evaluated objectively using a combination of metrics, such as the number of URLs visited, the number of queries used, search duration, etc. (Gwizdka & Lopatovska, 2009). *Search accuracy* is evaluated in terms of the accuracy of the end-of-search answer submitted by the searcher.

The cognitive-behavioral model suggests that individuals with high health anxiety are more likely to seek reassurance (Salkovskis & Warwick, 2001). Seeking reassurance can be done via medical consultation, physical examination, and searching for information on the Web. Many empirical studies, such as those discussed in Section 2.3.3, have suggested that higher health anxiety is associated with more frequent and prolonged OHIS (Baumgartner & Hartmann, 2011; Doherty-Torstrick et al., 2016;

McManus et al., 2014; Muse et al., 2012). Based on the literature, the following hypothesis is proposed:

H5: Individuals with higher health anxiety are likely to exert greater effort on OHIS than those with lower health anxiety.

Little is known about the relationship between health anxiety and search accuracy. However, because people with higher health anxiety are more likely to attend to illness-related information (Jasper & Witthöft, 2011; Owens et al., 2004) and more likely to interpret benign symptoms as severe illnesses (Hadjistavropoulos, Craig, & Hadjistavropoulos, 1998; Hitchcock & Mathews, 1992; Salkovskis & Warwick, 2001), one might reasonably assume that the search results obtained by individuals with higher health anxiety are likely to be less accurate compared to those with lower health anxiety. Therefore, the following hypothesis is proposed:

H6: The search outcome of individuals with higher health anxiety is less accurate compared to those with lower health anxiety.

Chapter 4: Method

This study employed an experimental approach to investigate the relationships between health anxiety and the cognitive, affective, and behavioral dimensions of OHIS. This approach was chosen because, as discussed in the Chapter 2, one methodological limitation of previous research is that most studies did not have participants engage in an actual search process, but instead relied solely on participants' self-recall of recent online search experience (e.g., Baumgartner & Hartmann, 2011; Eastin & Guinsler, 2006; te Poel et al., 2016). Previous studies suggest that data collected on the basis of the recall of distant experience are less reliable than those collected during or instantly after the experience of an event (Robinson & Clore, 2002). This dissertation addressed this limitation by taking an experimental approach that objectively recorded search behaviors during the search and collected self-recall data immediately after the search. In this chapter, I report the research design, participants, measurements, research site, search task, procedure, laboratory settings, and data analysis strategies.

4.1 Research design

A quasi-experimental design was implemented to test the research hypotheses: H1a to H4b were tested using a one-group, pre-post design involving two independent variables: health anxiety and search (pre, post); and 4 dependent variables: valence, arousal, control, and perceived health risk. H5 and H6 were tested using a one-group, post-only design with one independent variable, health anxiety, and two dependent

variables: search effort and search accuracy. In both designs, health anxiety was treated as a continuous variable.

4.2 PARTICIPANTS

Participants were recruited via convenience sampling from the University of Texas at Austin. Recruitment emails were sent via the University's UT Events Calendar email listserv, which sends daily information about university events and activities to the entire university community, including undergraduate and graduate students, faculty, and staff. Additional recruitment strategies included posting flyers around campus (e.g., in libraries, department buildings, gyms, student dorms, and activity centers) and contacting potential participants via personal contacts.

To be eligible, one must meet the following inclusion/exclusion criteria: (1) 18 years old or older, (2) comfortable using Google Chrome to conduct online searches, and (3) does not work or study in a health science-related field.

A total of 66 subjects were recruited to participate in the study, and 58 of them completed the experiment. Data analysis was based on data collected from these 58 participants. Participants' age ranged between 18 to 60 years (M=27.56, SD=8.87). Participants' health anxiety levels ranged between 3 to 32 (M=14.05, SD=6.09). The majority of participants were female, Asian or White Caucasian with Bachelor or above degrees, and had good or excellent health. Their demographics are presented in Table 1.

		N	%
Gender			
	Male	17	29.3
	Female	41	70.7
Race			
	American Indian/Alaska Native	2	3.4
	Asian	22	37.9
	African American	3	5.2
	Multi-racial	5	8.6
	White Caucasian	24	41.4
	Other	2	3.4
Ethnicity			
	Hispanic	10	17.2
	Non-Hispanic	48	82.8
Highest level of education			
	High school graduate/GED	4	6.9
	Some college/Associate degree	8	13.8
	Bachelor's degree (BA, BS)	19	32.8
	Master's degree (or other post-graduate training)	26	44.8
	Doctoral degree	1	1.7
Health status			
	Excellent	18	31.0
	Good	32	55.2
	Average	8	13.8
	Poor	0	0.0
Native English speaker			
	Yes	35	60.3
	No	23	39.7

Table 1: Sample demographics.

4.3 RESEARCH SITE

All sessions were conducted in the IT Lab at the School of Information at the University of Texas at Austin. The lab has 18 desktop computers with fast Internet connections. Google Chrome and the screen recorder application, Screencast-O-Matic[10], were pre-installed on all of the desktop computers.

[10] Screencast-O-Matic is a software company that develops screen recording and video editing softwares. Their screen recorder allows users to capture any area on the computer screen. It records the screen activities (including mouse clicking and keystroke) and audio input from computer and webcam. To learn more, visit https://screencast-o-matic.com/home.

4.4. MEASUREMENTS

A complete list of variables and measurements are listed in Table 2. All instruments can be found in Appendix A.

Variables		*Instruments/Tools*	*When to administer* 1	2	*Time to administer (min)*
Demographics		Nine items measuring basic demographics	X		5
Health anxiety		Short Health Anxiety Inventory (Salkovskis, Rimes, Warwick, & Clark, 2002): measures health anxiety with 18 items; each item is weighted on a 0-3 scale, and the total score is the summed score of all items. Higher score indicates higher health anxiety. Internal consistency (Cronbach's alpha coefficient) ranges from .74 to .96. and the mean score of concurrent validity is .43, based on a meta-analysis of 15 studies (Alberts, Hadjistavropoulos, Jones, & Sharpe, 2013).	X		8
Cognitive aspect: Perceived health risk		Four items adapted from Griffin, Dunwoody and Neuwirth (1999) and Griffin et al. (2008) measure self-reported perceptions of illness severity, susceptibility, self-efficacy and trust in medical professionals using a 5-point Likert scale. Higher score indicates greater perceived health risk.	X	X	5
Affective aspect: Valence, arousal, and control		Self-Assessment Manikin (Bradley & Lang, 1994): measures self-reported level of valence, arousal, and control with three items on a 9-point Likert scale. A higher score indicates that a person feels more positive, aroused, and in control. The test-retest coefficient ranges from 0.55-0.78, and concurrent validity ranges from 0.56-0.87 (Nabizadeh Chianeh, Vahedi, Rostami, & Nazari, 2012).	X	X	5
Behavioral aspect:	Search effort	Three items adapted from Gwizdka (2010): (1) number of unique queries used, (2) number of unique URLs visited, and (3) search duration.	Auto-recorded during search		
	Search accuracy	A score representing the accuracy of the diagnostic result submitted by the participants: 0: not accurate; 1: accurate	Manually scored after search		

Table 2: Measurements used and time of measurement (1: prior to online searching; 2: after online searching).

4.4.1 Health anxiety

Health anxiety was assessed using the 18-item Short Health Anxiety Inventory (SHAI), a shortened, validated version of the 64-item Health Anxiety Inventory developed by Salkovskis et al. (2002) based on the cognitive-behavioral model of health anxiety (Warwick, 1989; Warwick & Salkovskis, 1990). The items on the SHAI measure various aspects of health anxiety, such as general concerns about health, awareness of bodily sensations, and negative beliefs about illness consequences. The following is a sample item: "0 – I do not worry about my health; 1 – I occasionally worry about my health; 2 – I spend much of my time worrying about my health; 3 – I spend most of my time worrying about my health." Each item is scored on a scale of 0 to 3, and the total score ranges from 0 to 54, with a higher score indicating higher health anxiety.

The SHAI is a widely used scale for measuring health anxiety among both clinicians and researchers. It has two advantages: First, it is sensitive to both clinically significant and non-clinically significant health anxiety. Second, it has been validated and demonstrated good test-retest reliability (α = .74 - .96) and strong construct validity (see Alberts, Hadjistavropoulos, Jones, and Sharpe, 2013 for a review). In particular, the SHAI has been validated among college students in the U.S. (the same population as that in the present study) and has demonstrated satisfactory internal reliability (a = .86) and construct validity (Abramowitz, Deacon, & Valentiner, 2007).

4.4.2 Perceived health risk

Perceived health risk was assessed with four items adopted from Griffin et al. (2008), which were developed based on the RISP model (Griffin, Dunwoody & Neuwirth, 1999). The first item measures perceived severity of illness specified in the search scenario used for the present study. The second item measures perceived susceptibility of contracting the illness. The third item measures perceived self-efficacy in coping with the illness, and the last item measures perceived trust in medical professionals for taking care of the illness. Each item is rated on a 5-point Likert scale ranging from 1-completely disagree to 5-completely agree. Ratings of each item are summed into a composite score with higher score suggesting greater perceived health risk.

4.4.3 Affective state

Affective state was measured using the Self-Assessment Manikin (SAM) (Bradley & Lang, 1994). The SAM is a non-verbal, graphic scale that measures individuals' affective states across three dimensions on a continuum: valence (positive to negative), arousal (excited to calm), and control (controlled to in control). It consists of three sets of images (five in each set) representing the three dimensions of an affective state: The first set of images depict levels of valence, ranging from extremely positive to extremely negative. The second set of images depict levels of arousal, ranging from completely calm to highly aroused. The third set of images depict levels of control, ranging from being completely controlled to being completely in control. Participants are

asked to select any of the five figures or any of the four slots between the figures, which makes the SAM a 9-point scale. The SAM scale was chosen for the following reasons: (1) It has been widely used in both clinical and non-clinical populations and has demonstrated moderate to high reliability and validity (Grimm & Kroschel, 2005; Nabizadeh et al., 2012). (2) It is brief and easy to administrate. As noted in Gonzalez-Ibanez (2013), one of the advantages of non-verbal instruments is that it takes little time to complete them (approximately15 seconds), thus they are ideal instruments for measuring participants' affective states repeatedly during an experiment as it is in the present study. (3) The SAM has been used and validated in college student population which is the target population of the present study (e.g. Buck, Hillman, Evans, & Janelle, 2004; Chung & Jeglic, 2016).

4.4.4 Search behavior

Search behavior was measured by search effort and search accuracy. Search effort can be assessed with a combination of metrics that are indicative of the scope and depth of a search. For this study, three metrics that have been commonly used in previous research (e.g., Gwizdka, 2010; Zhang, 2013) were selected to assess search effort: (1) the number of unique queries used, (2) the number of unique URLs visited, and (3) search duration. The data for all these metrics were obtained by reviewing participants' screen activities, as automatically recorded by Screencast-O-Matic software, and the search logs saved in Google Chrome. Search accuracy was determined by comparing the diagnostic results submitted by the participants at the end of search against the correct diagnosis.

4.4.5 Open-ended question

In addition to the above quantitative measures, following the search, participants were asked to write down the answer to one open-ended question at the end of the post-search questionnaire: "Please describe your search process (e.g. the steps you took, your thinking process and feelings at each step)." The purpose of the open-ended question was *not* to answer any specific research question, but to obtain additional information about people's search behavior and to provide contextual information that may assist interpretation of the quantitative analysis results.

4.5 SEARCH TASK

Each participant was presented with a predetermined search scenario that contains an illness case with a description of a set of symptoms. Participants were asked to perform an online search and find out the most likely diagnosis of the illness case. The illness case was selected from the book *Symptom to Diagnosis – An Evidence-Based Guide* (Stern, Cifu, & Altkorn, 2015). This clinical guide is based on the Core Medicine Clerkship Curriculum Guide of the Society of General Internal Medicine/Clerkship Directors in Internal Medicine. It includes actual patient cases that cover a variety of common symptoms and diseases. For each case, a leading diagnosis is provided, and clinical reasoning is clearly articulated. For the purpose of the present study, the wording of the illness case was modified by only retaining symptom information self-reported by the patient and omitting information obtained from physical exams and laboratory tests. The illness case and its leading diagnosis are listed below:

This morning my college roommate started to complain about diffuse pain in her mid/upper abdomen. She described the pain as pressure-like, which she never experienced before. A few hours have passed, and she feels that the pain has gotten more intense towards the right lower abdomen. She has a low fever but no nausea or diarrhea. Does anyone know what's wrong with her?

Leading diagnosis: Appendicitis

Considering the purpose of the present study, an ideal illness case should meet the following criteria: (1) It should have a moderate level of complexity – it should not be too complicated or too easy for someone without a medical background to figure out the diagnosis. If an illness case is too complicated, very few people would be able to find out the right diagnosis and the results would be skewed. The same theory would apply if an illness case is too easy. At the pilot stage, I asked five participants (one had a medical background) to conduct an online search to find out the diagnosis of three illness cases, including the appendicitis case. It turned out that no one was able to find out the correct diagnosis for the other two cases because they both involved many complications that made diagnosis rather challenging without further consultation and medical tests. Two out of the five participants were able to find the correct diagnosis for the appendicitis case. (2) An ideal case should not contain symptoms that appear to be too severe, such as extreme pain, severe bleeding, convulsion and etc. Such severe symptoms may elicit high anxiety even for people with lower health anxiety, which means it would be hard to detect a difference of affective responses between people with higher and lower health anxiety. (3) An ideal case should be somewhat relevant to the study population which is

college students. According to Mayo Clinic (2019, May 24), appendicitis is most likely to occur in people between the ages of 10 and 30, and therefore is relevant to the study population. With the above factors taken into consideration, appendicitis seems to be an appropriate case to use for this study.

4.6 PROCEDURE

Groups of participants (3-8 per group) were scheduled for a 90-minute session in the IT lab at the School of Information at University of Texas in Austin. Detailed steps are summarized in Table 3. After all participants in the room completed the background questionnaire, the researcher introduced the search task and presented the search scenario on the projector screen in front of the room. Then, participants were instructed to complete the pre-search questionnaire before performing the search task independently on their assigned desktop computers. Participants were asked to press the "Record" button to trigger the screen recorder before began with the search and "Stop" the recording after completed the search task. Therefore, the beginning and end time stamp for completing the search task was automatically recorded for each participant separately. Participants were allowed to take as much or little time as they needed to complete the search task.

Step	*Description*	*Time (min)*
1	Researcher introduced the research background and steps.	5
2	Participants read and signed the informed consent form.	5
3	Participants completed the background questionnaire (demographics and SHAI).	10
4	Researcher introduced the search task and presented the search scenario to the participants.	5
5	Participants completed the pre-search questionnaire (perceived health risk and SAM).	5
6	Participants performed online searching independently and made a diagnosis based on the information found online.	No limit
7	Participants completed the post-search questionnaire (perceived health risk, SAM, and one open-ended question that collected data about their reflections of the search process).	15
8	Participants were thanked and provided with compensation.	5

Table 3: Experiment steps.

4.7 DATA ANALYSIS STRATEGIES

Before proceeded with data analysis to test the research hypotheses, data were preprocessed and explored. This procedure included computing measures, identifying missing values, examining descriptive statistics, and testing statistical assumptions.

The sum score of SHAI for each participant was calculated. Ratings of the four items measuring perceived health risk pre- and post-search were summed to achieve the composite scores. The automatically recorded search logs and screen recordings were examined manually to obtain the counts of the three variables measuring search effort: unique search queries used, unique URLs visited, and time spent on task. A composite score[11] was computed following strategies suggested in (Song, Lin, Ward, & Fine, 2013) for the three dependent variables measuring search effort. To evaluate search accuracy,

[11]Data for all three variables were converted to *z* scores which were then computed to form a regression-weighted composite score using principle component analysis (PCA). Cronbach's alpha based on the transformed scores was .803, indicating good internal reliability. Results from PCA revealed one component, suggesting unidimensionality. Therefore, it is appropriate to combine the three measures into one composite score.

participants' submitted diagnoses were compared against the correct diagnosis (i.e. appendicitis). Search accuracy was coded as 1 if the submitted answer is appendicitis and coded as 0 if the submitted answer is something else.

To test H1a through H4b, linear mixed effect model was performed in R with *MCMCglmm* package (Hadfield, 2010) to account for the repeated measures (i.e. perceived health risk, valence, arousal and control). To test H5 and H6, a simple linear regression and a binominal regression was performed respectively. Statistical assumptions (i.e. linearity, absence of collinearity, homoskedasticity, etc.) were tested before running the analysis and results are included in Appendix B.

Chapter 5: Results

This chapter presents the study findings. First, descriptive statistics of the outcome variables were summarized. Then, results of the statistical analyses for each research hypothesis were presented. Lastly, findings from the open-ended question were presented.

5.1 DESCRIPTIVE STATISTICS

There was no missing value for any of the outcome variables. The descriptive statistics for the outcome variables are summarized in Table 4. The descriptive statistics show that the average rating of perceived health risk of all participants went up following the search. The average ratings of valence before and after the search were highly skewed towards the negative side of the scale. The average ratings of arousal and control before and after search sit around the middle point of the scale, indicating somewhat a neutral state. The average ratings of valence and arousal went down only slightly after search, meaning that participants felt more negative and less aroused following the search. The average rating of control went up slightly after the search, meaning participants felt more in control after the search. The number of unique queries used by participants ranges from 1 to 22 (mode = 4, median = 4). The number of unique URLs visited by participants ranges from 3 to 57 (mode = 11, median = 12). Time on task rages from 2 mins to 48 mins (M = 27.14, SD = 11.74). The total of 18 different diagnoses (including appendicitis) were submitted.

		M	*SD*
Perceived health risk	Pre	9.72	2.02
	Post	11.16	2.17
Valence	Pre	2.91	1.45
	Post	2.76	1.36
Arousal	Pre	5.88	1.27
	Post	5.72	1.78
Control	Pre	4.67	1.81
	Post	4.71	1.89
Search effort	Query	5.81	4.85
	URL	15.55	12.12
	Duration (min)	27.14	11.74
		n	%
Search accuracy	Accurate	36	62%
	Inaccurate	22	38%

Table 4: Descriptive statistics of outcome variables (N = 58).

5.2 RELATIONSHIPS BETWEEN HEALTH ANXIETY AND THE COGNITIVE DIMENSION OF OHIS

A linear mixed effect model was applied in R with the *MCMCglmm* package (Hadfield, 2010) to account for the repeated measures of perceived health risk. Health anxiety level and search (pre, post) were entered into the model as fixed effects, and intercepts for subjects were entered as random effects. Results are summarized in Table 5.

	β	*SE*	t-value	p-value
(Intercept)	8.832	0.565	15.628	<0.001
Health anxiety	0.114	0.369	3.096	**0.003**
Search	0.912	0.343	2.659	**0.010**
Health anxiety × Search	0.014	0.022	0.624	0.534

Table 5: Results of linear mixed effect model for testing the relationship between health anxiety and perceived health risk.

There was no statistically significant interaction effect of health anxiety and search (pre, post). H1a was not supported. Statistically significant main effect of health anxiety on perceived health risk was found. More specifically, individuals with higher health anxiety perceived significantly greater health risk than those with lower health anxiety, regardless of the search (β = .114, SE = .369, p = .003). H1b was supported. Although the main effect of search (pre, post)) was not proposed as a research hypothesis, it was indeed found that perceived health risk increased statistically significantly following the search, regardless of one's health anxiety level (β = .912, SE = .343, p = .010). The presence of significant main effects of health anxiety and search without the presence of a significant interaction effect implies: (1) search was not a function of the relationship between perceived health risk and health anxiety, meaning that the difference of perceived health risk between people with higher and lower health anxiety did not differ statistically significant before and after the search; (2) health anxiety was not a function of increased perceived health risk following the search. In other words, change of perceived health risk following the search did not differ statistically significantly between people with higher and lower health anxiety.

5.3 RELATIONSHIPS BETWEEN HEALTH ANXIETY AND THE AFFECTIVE DIMENSION OF OHIS

A linear mixed effect model was applied in R with the *MCMCglmm* package (Hadfield, 2010) to account for repeated measures of the affective variables (i.e., valence, arousal and control). Health anxiety level and search were entered into the model as fixed effects, and intercepts for subjects were entered as random effects. Results are summarized in Table 6.

	Valence			
	β	*SE*	t-value	p-value
(Intercept)	3.676	.362	10.137	<0.001
Health anxiety	-.060	.023	-2.521	**.015**
Search	-.047	.274	-.171	.865
Health anxiety × Search	.009	.018	.494	.624
	Arousal			
	β	*SE*	t-value	p-value
(Intercept)	5.492	.442	12.429	<0.001
Health anxiety	.022	.029	.762	.449
Search	-.027	.266	-.102	.919
Health anxiety × Search	.007	.017	.429	.670
	Control			
	β	*SE*	t-value	p-value
(Intercept)	5.311	.561	9.472	<0.001
Health anxiety	.044	.367	1.206	.233
Search	.167	.250	.667	.508
Health anxiety × Search	.011	.016	.651	.518

Table 6: Results of linear mixed model for testing the relationship between health anxiety and valence, arousal and control.

There was no statistically significant interaction effect for health anxiety and search on valence, arousal or control. H2a, H3a and H4a were not supported. The main effect of health anxiety was statistically significant on valence. Higher health anxiety is associated with more negative valence, regardless of search (β = .912, *SE* = .343, $p <$ .05). H2b was supported. This implies that search was not a function on the relationship between health anxiety and valence. In other words, the difference of valence between people with higher and lower health anxiety did not differ before and after search. No other main effect of health anxiety was found on arousal or control. H3b and H4b were rejected.

5.4 RELATIONSHIPS BETWEEN HEALTH ANXIETY AND THE BEHAVIORAL DIMENSION OF OHIS

H5 proposes that individuals with higher health anxiety are likely to exert greater effort in online health information searches than those with lower health anxiety. A simple linear regression was performed but found no statistically significant relationship between health anxiety and the composite score of search effort (Table 7). H5 was not supported.

	F	*df*	*β*	R^2	*p*
Search effort	.944	1	-.046	.017	.335

Table 7: Results of simple linear regression for testing the relationship between health anxiety and search effort.

H6 proposes that individuals with higher health anxiety are less likely to find accurate information than those with lower health anxiety. Search accuracy rates are presented in Table 4 above. A binomial logistic regression was performed to examine the relationship between health anxiety and search accuracy. The results show that health anxiety was a statistically significant predictor of search accuracy, $\chi^2(1) = 6.928, p = .017$ (Table 8): individuals with higher health anxiety were more likely to find the accurate diagnosis. This finding is opposite to what was proposed in H6.

	B	*S.E.*	*Wald*	*df*	*p*	Odds ratio
Health anxiety	.146	.060	5.875	1	**.017**	1.157
Constant	-1.546	.821	3.543	1	.060	.213

Table 8: Results of logistic regression for predicting search accuracy based on health anxiety.

5.5 FINDINGS FROM THE OPEN-ENDED QUESTION

In the post-search questionnaire, participants were asked to write down their answers to one open-ended question: "Please describe your search process (e.g. the steps you took, your thinking process and feelings at each step)". The purpose of the open-ended question was to obtain contextual information about their search process that might assist interpreting the quantitative analysis results; it was not meant to answer any specific research question or to verify any research assumption. Participants' answers vary in terms of thoroughness and focus. Some simply described the queries they used and the URLs of the websites they visited, while others provided thorough descriptions of the steps they took and their thoughts at each step (e.g., how they thought about the information on a website and why one diagnosis was more likely than others). This section summarizes the main findings identified in the responses to the open-ended question.

First, participants from both the higher and lower end of health anxiety levels mentioned having a preconception of what the diagnosis might be prior to searching. Among them, most people had a preconceived diagnosis that matches the accurate diagnosis. Their search tended to start with a search of the preconceived diagnosis to determine whether the symptoms matched those described in the search scenario used in the present study. Even though some participants noticed that some of the symptoms described in the search scenario did not match what they read online (e.g. nausea or vomiting is one of the classic symptoms of appendicitis but it is not present in the search

scenario), they still chose to stick to their preconceptions. As one participant wrote: "Appendicitis was already my first thought for a possible diagnosis when reading the prompt from my prior knowledge of the disease… I then searched in Google for articles more specifically about appendicitis… but in the scenario given she does not feel nauseous. Since the other symptoms match so perfectly to appendicitis, this did not dissuade me…" (Participant #28, female, age 19). For participants who did not have a preconception, their search procedure tended to be more exploratory, starting with a general search and then narrowing down to more specific areas. They tended to start searching either in Google or an online symptom checker using the individual symptoms as keywords, which exposed them to a number of possibilities. Then, they tried to "narrow down" the possibilities to a shorter list of 2-3 diagnoses, and to compare each diagnosis against the search scenario to determine the most likely diagnosis.

Second, people with higher health anxiety seemed to perceive the illness as more severe than those with lower health anxiety. Participants with lower health anxiety appeared to downgrade the severity of the illness, considering the condition as "not that bad" or resisting the thinking of severe illness. As one participant whose health anxiety level was at the lower end noted "If she was suffering from appendicitis, she would have more symptoms... However, for now I'm likely to believe she has gas" (Participant #37, female, age 44). This echoes with findings from the quantitative analysis that health anxiety was positively associated with perceived health risks.

Third, although people with higher health anxiety tended to inflate the severity of the illness, describing it as a serious problem that needed immediate medical attention,

there was no sign of escalated search for extremely severe and rare conditions like cancer. In fact, many participants (both with higher and lower health anxiety) noted that online information could sometimes be exaggerated and misleading. They would either purposively avoid visiting websites that "spreading unreasonable fear" or verify information validity by cross-checking multiple information sources. For example, one participant noted "I found a few results mentioning cancer, and I just didn't feel like clicking on them. I guess my thought process was telling me to not imagine the most extreme possibilities, and look for more probable explanations…" (Participant #13, male, age 34).

Fourth, participants from both the higher and lower end of health anxiety levels expressed a preference for information published on what they considered as credible websites. One participant with higher health anxiety (SHAI=21) wrote: "On searching I chose to check a link from the Mayo clinic, rather than Web MD, because I know it to be a reputable institution which is less quick to jump to the worst case scenario - which I think WebMD does do, at times" (Participant #49, female, age 36).

5.7 SUMMARY

This chapter reported the data analysis results. Statistically significant main effects of health anxiety and search (pre, post) were found: Participants' perceptions of health risk increased significantly following the search, and participants with higher health anxiety perceived greater health risk than those with lower health anxiety. However, the interaction effect of health anxiety and search was not statistically

significant on perceived health risk. Second, the interaction effect of health anxiety and search on the affective dimension of OHIS was not statistically significant; however, health anxiety had a main effect on valence: higher health anxiety was associated with greater negative valence. Health anxiety did not predict arousal and control. Third, higher health anxiety was not associated with greater search effort. However, it was found that health anxiety was a statistically significant predictor of search accuracy. Increases in health anxiety led to increased probability of finding the correct diagnosis.

Chapter 6: Discussion

This chapter includes discussions of the main findings, contributions and implications, study limitations, and future research directions.

6.1 DISCUSSIONS ON MAJOR FINDINGS

6.1.1 Relationships between health anxiety and the cognitive dimension of OHIS

Study findings show that the interaction effect of health anxiety and search on perceived health risk was not statistically significant. However, participants' perceptions of health risk went up significantly following the search, regardless of participants' health anxiety levels. In addition, this study found that individuals with higher health anxiety perceived significantly greater health risk than those with lower health anxiety, regardless of search. Such finding is in consistent with the theoretical assumptions of the cognitive-behavioral model of health anxiety. According to the model, people with higher health anxiety tend to develop catastrophic thinking of symptoms and disease; and are more likely to attend to information indicative of severe illness while dismissing information of benign explanations (Salkovskis & Warwick, 2001; Taylor & Asmundson, 2004; Warwick, 1989).

Findings from the open-ended question seem to be in line with the results of the quantitative analysis. First, participants with higher health anxiety tended to describe the illness case as more severe than those with lower health anxiety. Second, it was found that after reading about the illness case for the first time, some participants already had a

preconception of what the illness might be while others might not. After the search, many people, regardless of their health anxiety levels, believed the illness scenario was more severe than what they had initially anticipated, even for those whose preconceived diagnosis was in line with the information found online. This suggests that online information might exaggerate perceptions of the health problem's severity. This finding is consistent with what have been reported in the literature (Chu et al., 2017; Singh et al., 2016; White & Horvitz, 2009a).

6.1.2 Relationships between health anxiety and the affective dimension of OHIS

6.1.2.1 Relationship between health anxiety and valence

This study found a main effect of health anxiety on valence: individuals with higher health anxiety experienced significantly greater negative valence compared to those with lower health anxiety. As discussed in Section 6.1.1, people with higher health anxiety perceived greater health risk than those with lower health anxiety, which may render them more susceptible to worries and concerns about the illness. Finding of the positive relationship between health anxiety and negative valence confirms the theoretical assumptions discussed in Chapter 3. It also complements and extends the findings of previous studies which found a positive correlation between health anxiety and negative valence after search (Baumgartner & Hartmann, 2011; Doherty-Torstrick, Walton, & Fallon, 2016; Muse et al., 2012). It is necessary to note that these previous studies did not use a standard scale to measure valence, but used self-developed questions to measure a

number of specific negative valence, such as distress, fright, anxiety etc. In spite of the different measurements being used, the present study reached the similar conclusion as those in the previous studies.

It is also important to note that these previous studies used cross-sectional survey methods to examine the correlation between health anxiety and negative affect *after* search; they did not have participants involved in an actual search to measure their negative affect *before and after* the search. It is necessary to do so because only by measuring their negative affect at baseline, are we able to determine if there is any difference before and after the search, and whether such difference (if any) differs by level of health anxiety (the interaction effect of health anxiety and search). Only knowing health anxiety is correlated with negative affect *after* search is not enough because negative affect may already present for those with higher health anxiety even before they begin the search. As discussed in the literature review chapter, people with higher health anxiety are more likely to have catastrophic interpretations on common bodily symptoms (Hadjistavropoulos et al., 1998; Hitchcock & Mathews, 1992; Pauli et al., 1993). Thus, it is reasonable to speculate that when noticing unfamiliar bodily symptoms, people with higher health anxiety could already develop negative affect even before doing any online searches about the symptoms. Without comparing the level of negative affect before and after the search, it is difficult to decipher if online searching itself would have any impact on people's negative affect, and whether online searching and the intrinsic health anxiety may have an interaction effect on the experienced negative affect. Therefore, measuring the interaction effect of health anxiety and search, as done in the present study, can tell us

more about whether the negative affect is likely due to health anxiety or due to search or both.

Knowing whether negative affect is a consequence of health anxiety or search can inform clinicians and system developers to develop the right intervention that helps mitigate the negative affect – if negative affect is likely due to online search and has nothing to do with health anxiety, then effort should be placed in improving the search environment; if negative affect is likely due to health anxiety despite of the search, then effort should be placed in treating health anxiety; if negative affect is a consequence of the interaction effect of intrinsic health anxiety and online search, then it is necessary to customize the search environment for people with different levels of health anxiety. The present study found a significant main effect of health anxiety along with the absence of the main effect of search and the interaction effect, which suggests that the difference of negative affect is likely due to health anxiety, not the search. In other words, compared to those with lower health anxiety, people with higher health anxiety are at higher risk of experiencing negative affect regardless of the search procedure they undertake.

6.1.2.2 Relationship between health anxiety and arousal

The cognitive-behavioral model predicts that people with higher health anxiety tend to experience higher arousal as a result of catastrophic thinking of the symptoms (Warwick, 1989). Therefore, it is reasonable to speculate that compared to people with lower health anxiety, people with higher health anxiety would experience greater arousal towards the illness case regardless of the search (the main effect of health anxiety) and

would have greater increases in arousal after searching and reading illness information online (interaction effect of health anxiety and search). However, the present study did not find a significant main effect of health anxiety nor an interaction effect of health anxiety and search.

These results are likely due to an ambiguity of, and as a result, misinterpretation of the questions in the SAM scale. Previous studies that used SAM to measure affect have also noted that the ambiguity of the meaning of the images in SAM may sometimes cause confusion and misinterpretation which could potentially lead to inaccurate assessment (Hayashi, Posada, Maike, & Baranauskas, 2016; Hogarth, Portell, Cuxart, & Kolev, 2011). In SAM, arousal is measured by the *calm-excited* scale. In describing arousal, the scale uses a mix of adjunctive words that express a positive (e.g. excited, relaxed), negative (e.g. frenzied, sluggish) or neutral tone (e.g. wide-awake, sleepy). But given the context of the present study, arousal should be described more preciously with a negative tone, such as anxious, jittery, worried or distressed. Despite that both feeling excited and anxious can be specific manifestations of arousal, they represent very distinct affective states. For instance, in answering the open-ended question, one participant whose arousal level went up following the search noted that "My feeling throughout was excitement to know what I thought beforehand correlated with the symptom checker". Based on her comment, it is likely to assume that she might perceive excitement as a form of arousal, and her increased arousal had less to do with her perception of the illness but is more of a result of satisfaction with her search experience. As argued above, such misinterpretation of the scale may result in inaccurate assessment.

Despite of the potential constrains, I chose to use SAM scale for the present study at the first place for justifiable reasons: (1) it is a widely used and validated instrument for measuring dimensions of affect (Grimm & Kroschel, 2005; Nabizadeh et al., 2012), (2) its simple format is ideal for experimental design with repeated measures and (3) it has been used to measure affect in the context of collaborative information seeking (but not related to health information seeking or health anxiety) (Gonzalez-Ibanez, 2013). SAM scale intends to measure valence, arousal and control in a *general* sense (Bradley & Lang, 1994). However, findings from the open-ended question, as those mentioned above, might have suggested that using a general instrument like SAM to measure affective experience in a specific context may not be as effective, which adds to the concerns expressed by others (Hayashi, Posada, Maike, & Baranauskas, 2016; Hogarth, Portell, Cuxart, & Kolev, 2011). Proper adaptation with added specification of the context might be necessary to avoid ambiguity.

6.1.2.3 Relationship between health anxiety and control

The cognitive-behavioral model suggests that people with higher health anxiety may consider themselves less capable of coping with the perceived health threat and are more likely to seek medical consultation for reassurance (Salkovskis & Warwick, 2001; Warwick & Salkovskis, 1989). Therefore, I hypothesized that people with higher health anxiety would feel less in control when searching for the diagnosis of the illness case. However, the present study found no statistically significant difference in control among participants with higher and lower health anxiety. The absence of a statistically

significant relationship between health anxiety and control might be due to different interpretations of control. In the context of this study, control should have been interpreted as control over the illness, but it might have been interpreted as control over the search. It is evident in responses to the open-ended question that some participants felt overwhelmed by the amount of the information and struggled with unfamiliar medical terminologies. One participant noted "At this point the website returned a long list of about 15 diagnoses and I felt a little overwhelmed and unsure about what to do next" (Participant #26, female, age 35)". Another participant mentioned that "I am quite calm throughout the whole process. The only moment when I got a slight tint of concern is when I realized there are a lot of medical vocabularies that I don't know" (Participant #51, female, age 21). This could indicate a lack of control over the search. As some participants might misinterpret control as control over the search, instead of control over the illness, their ratings of control might not be as accurate.

6.1.3 Relationships between health anxiety and the behavioral dimension of OHIS

This study examined the relationships between health anxiety and two behavioral variables of OHIS, search effort and search accuracy. The cognitive-behavioral model suggests that people with high health anxiety often engage in excessive reassurance seeking in a form of medical examination or OHIS. Findings of empirical studies also show that health anxiety is positively associated with frequency of OHIS (Baumgartner & Hartmann, 2011; Singh & Brown, 2014; te Poel et al., 2016). Therefore, it is speculated that people with higher health anxiety might devote more effort into search than those

with lower health anxiety. However, findings of the present study did not reveal a statistically significant relationship between health anxiety and search effort. This suggests that although people with higher health anxiety may search more frequently than those with lower health anxiety, they might not necessarily always exert more effort in a single search session.

Interestingly, this study found that participants with higher health anxiety were more likely to find the correct diagnosis, despite that participants with higher health anxiety appeared to use fewer queries, visited fewer URLs and spent less time on search. Together, the results seem to suggest that people with higher health anxiety might be more efficient at OHIS. This may be due to the fact that people with higher health anxiety have more Internet usage experience for health-related purposes (Singh & Brown, 2014), and thus become more proficient in accomplishing a search task. Another possible reason is that accomplishing a search task with a hypothetical versus a real-life scenario might have different impact on health anxious people's search performance. As Keselman, Browne and Kaufman (2008) suggested, the hypothetical nature of a search scenario may not evoke the same level of emotions that would have been evoked by a real-life health problem of oneself or significant others. Evoked negative affect is associated with reduced search efficiency (Gonzalez-Ibanez, 2013) and worsened logical reasoning (Jung, Wranke, Hamburger, & Knauff, 2014). Therefore, it is reasonable to speculate that when performing a search task on a hypothetical scenario compared to a real-life scenario, people are less likely to be influenced by intensive negative affect and are more likely to think logically and search strategically.

6.2 CONTRIBUTIONS AND IMPLICATIONS

6.2.1 Theoretical contributions

Not until recent years did researchers start to investigate the role of health anxiety in OHIS. The majority of published studies were conducted under the influence of the cognitive-behavioral model of health anxiety, with little connection to the literature in information science. As a result, existing studies treated OHIS only as a general behavioral outcome (i.e., intention and frequency of engaging in OHIS). This dissertation study made a theoretical advancement by integrating the theoretical models and concepts from psychology and information science into one conceptual framework – the eHealth Anxiety Model (eHAM). To the best of my knowledge, this is the first study that examined the cognitive-behavioral model of health anxiety in the theoretical frameworks of information seeking. The eHealth Anxiety model was initially proposed based on existing theories from the two domains. The model suggests that OHIS was a dynamic process that incorporates an interplay of the cognitive, affective and behavioral dimensions, and health anxiety as the center of the model has a positive or negative impact on these three dimensions during the search process. Findings of this research did not support the interaction effect of health anxiety and search (pre, post) on any of the cognitive, affective and behavioral variables of OHIS, but did provide evidence in supporting the main effect of health anxiety on some of the variables:

First, consistent with the assumption generated from the cognitive-behavioral model of health anxiety, result of the present study suggests a positive (+) relationship

between health anxiety and perceived health risk which represents the cognitive dimension of OHIS. Second, also consistent with the assumption generated from the cognitive-behavioral model of health anxiety, result of the present study supports a positive (+) relationship between health anxiety and negative valence which is one of the affective dimensions of OHIS; but the result does not suggest a relationship between health anxiety and the other two affective dimensions of OHIS – arousal and control. Third, the highlight of the eHealth Anxiety Model is the discovery of a positive (+) relationship between health anxiety and search accuracy – this is contrary to what the cognitive-behavioral model implies. The cognitive-behavioral model suggests that people with higher health anxiety are more likely to be attracted to severe medical explanations and therefore are less likely to identify the correct diagnosis. In contrast, findings of the present study shows that people with higher health anxiety were more likely to find the correct diagnosis. One plausible reason is that the cognitive-behavioral model, although has been widely accepted, was developed prior to the Internet age. At that time, the general public had constrained access to health information and limited information literacy; therefore, they were less capable to self-diagnose themselves. However, nowadays, people not only have access to tremendous amount of health information but also with much improved information literacy. Therefore, the assumption suggested in the cognitive-behavioral model might no longer be applicable. Based on the results of the experiment, I revised eHAM as shown in Figure 7.

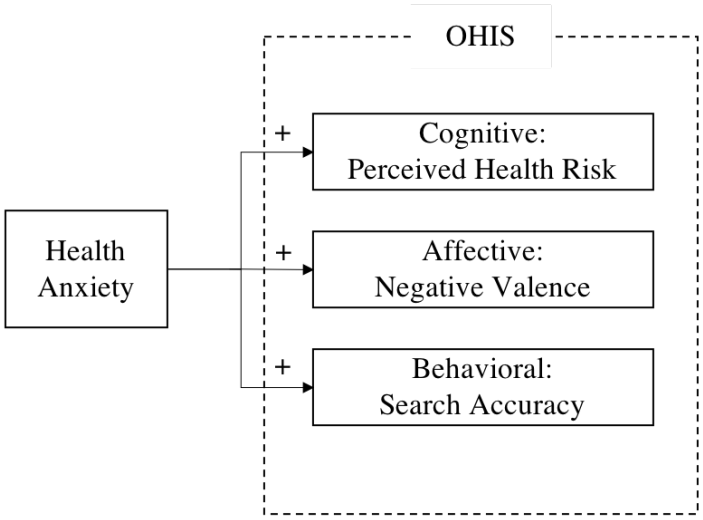


Figure 7: Revised eHealth Anxiety Model (eHAM).

6.2.2 Practical implications

The discovery of a positive relationship between health anxiety and information search accuracy could have important practical implications in clinical settings. Some traditional clinical interventions for treating health anxiety were developed based on the cognitive-behavioral model (Taylor & Asmundson, 2004). They recommend strategies that either limit or prevent people from seeking disease-related information (Taylor & Asmundson, 2004). Doing so may help reduce the chance of being exposed to concerned illness information, but it might also prevent people from practicing their information search skills that could be beneficial for managing their health lives. Results of the present study suggest that even though people with higher health anxiety perceived greater risk of the illness, it did not make them less capable of finding the right

information. In fact, as they practice OHIS more frequently, they may become more skilled and are more likely to find the right information efficiently, as observed in the present study. Therefore, in developing clinical intervention for treating online health anxiety, asking patients to avoid searching for health information online might not be the only or the optimal approach, and practitioners should focus on providing proper guidance and practices that help health anxious individuals to learn how to identify credible information and to control the development of catastrophic thinking and escalated anxiety that may occur during the search (Starcevic & Berle, 2013).

6.2.3 Methodological contributions

In investigating the relationships between health anxiety and OHIS, this study used research methods and measurements that were different from the previous studies. Most studies of the relationship between health anxiety and OHIS took a retrospective approach to gather participants' feedbacks based on their self-recall of recent online search experience without having participants engaging in an actual search process. These previous studies applied a cross-sectional survey approach to study the correlations between health anxiety and OHIS (Baumgartner & Hartmann, 2011; Eastin & Guinsler, 2006; Muse et al., 2012). Unlike these previous studies, the present study implemented an experimental approach with repeated design in which participants were asked to perform an actual search task, and their cognitive, affective and behavioral feedback were collected before and immediately after the search. Compared to the cross-sectional survey approach that relies on participants' self-recall of past experience, the experimental

approach used in the present study has at least two benefits: First, in the present study, data were collected during or immediately after the experience of the search event, which is more reliable than those collected based on recall of distant experience (Robinson & Clore, 2002). Second, the cross-sectional survey method can only measure the correlations between health anxiety and some aspects of OHIS at one specific time point. For example, in a study conducted by Baumgartner and Hartmann (2011), the researchers measured participants' health anxiety levels and asked how frightened they felt after their last OHIS. Although a positive correlation between health anxiety and feeling frightened after search was found, one cannot tell whether feeling frightened after search was due to health anxiety or due to the search itself because people with high health anxiety might already feel frightened even before the search. Therefore, taking an experimental approach with repeated design can help bridge this knowledge gap.

6.3 STUDY LIMITATIONS AND FUTURE DIRECTIONS

This study has limitations. First, a convenience sample of college students and staff in the University of Texas at Austin was used in this study. This sample represents a relatively young, healthy population who are less prone to health anxiety than, for example, older adults who may have many health complications (El-Gabalawy, Mackenzie, Thibodeau, Asmundson, & Sareen, 2013).

The majority of participants had a health anxiety level lower than the threshold of clinically significant health anxiety.[12] As a result, this sample may not demonstrate sufficient cognitive, affective and behavioral traits of health anxiety that are easily observable in an experiment. In addition, the study sample was also more educated and probably more skilled in online searches than the average. This might have an impact on the generalizability of the research findings. Therefore, future studies should consider utilizing a sample with a mix of clinically and non-clinically health anxious individuals of various ages and socioeconomic statuses to examine whether the relationships of health anxiety and OHIS may differ by health anxiety levels or any demographic characteristics.

Second, results of the present study are based on the use of one search task with one illness scenario (i.e. appendicitis). It is possible that the results might have been different if a different scenario was chosen – a scenario involving an illness case more or less severe than appendicitis. One major reason that only one scenario was used in this study was to control session length. At the pilot study stage, I used two search scenarios and the total session lasted about 2 hours. In addition, in the end-of-session interviews, all participants reported that both search scenarios required intensive mental effort. One participant found it hard to stay focused for such a long period of time. One reported feeling tired and started to lose interest when doing the second task. Findings from the

[12]Research suggests that a cut-off point of 18 or higher is reliable in identifying people meeting the diagnostic criteria for clinically significant health anxiety (Barsky & Klerman, 1993, Warwick & Salkovskis, 1990), while a score between 15 and 17 represents a mixture of people who meet the diagnostic criteria of clinically significant health anxiety and people are highly health anxious but just miss the criteria for clinical diagnosis (Rode et al., 2006).

pilot testing seem to suggest that the quality of participants' performance on the search task might decline as their mental exertion increased, and this might have some negative impact on the experiment results. Future studies may consider implementing a between-subject design using more than one scenario with one being more severe than the other in order to examine whether severity of the illness may have any impact on the relationships between health anxiety and OHIS.

Third, the present study used one hypothetical search scenario for all participants. Hypothetical scenario has been used in many previous research (Baumgartner & Hartmann, 2011; Singh & Brown, 2016) and have been reported as having many advantages such as protecting personal privacy (Herskovits, 1950). However, one potential problem of using a hypothetical search scenario, instead of a real-life scenario, is that it might not evoke strong affective and cognitive responses due to a lack of personal relevance (Bayer, Ruthmann, & Schacht, 2017). In other words, participants might not be as cognitively and affectively engaged as they would have been if they were asked to search for something that had a direct impact on themselves or significant others. This might, to some extent, account for the insignificant results of some of the outcome measures. However, the problem of using a real-life experience in the present research context seems to be a bigger one: If allowing participants to conduct a search based on their own real-life scenarios, it would be hard to tell whether any difference in the outcome variables was due to differences in their health anxiety levels or due to differences in the search scenarios that participants choose themselves. After weighing these pros and cons carefully, I decided to proceed with a hypothetical scenario in order

to control for additional variance that may be introduced by differences in the search scenario. In addition, using a hypothetical scenario allowed the researcher to objectively evaluate the accuracy of the diagnostic results submitted by the participants. As introduced in Chapter 4, the illness case used in the present study was chosen from a medical guideline which provides the correct diagnosis for each case (Stern, Cifu, & Altkorn, 2015). The correct diagnosis as specified in the medical guideline was used to evaluate the accuracy of the diagnostic results submitted by the participants. If allowing participants to conduct a search based on their own real-life scenarios, the researcher would be unable to assess the accuracy of their search outcomes without consulting medical professionals, which would require additional resources (e.g., consulting fees) that this project did not have.

Fourth, examinations of the responses to the open-ended question have revealed that many participants, regardless of their health anxiety levels, already had a perceived notion of what the diagnosis might be before doing any search. They began by searching for symptoms of the perceived diagnosis to determine whether what they read online matched those described in the search scenario. Even though some participants noticed that some of the symptoms did not match well, they still chose to stick to their assumptions. This seems to suggest that perceived familiarity on the topic or perceived personal relevance of the topic may have an impact on their information search behavior, but this was not examined in the present study. Although there is evidence in the information science literature suggesting that topic familiarity and perceived self-relevance could have a potential effect on information search behavior (e.g. Kelly &

Cool, 2002), there's no clear research evidence that has suggested that perceived topic familiarity or relevance has an impact on any of the relationships between health anxiety and OHIS investigated in the present study. But this is something worthwhile to explore in future studies.

Fifth, none of the three affective measures (valence, arousal and control) showed statistically significant changes before and after the search. The absence of statistically significant change might be due to the limitations of the measurements. First, while the SAM scale has been widely recognized as a reliable measurement of affect, it is still limited for measuring affect specificity given a specific research context – a commonly argued pitfall of self-report measurement of affect (Mauss and Robinson, 2009). The second constrain of self-reports of affect is a lack of timeliness and relatedly a lack of sensitivity (Mauss and Robinson, 2009). In the present study, participants were asked to report their affective state before and immediately after the search. Although doing so is better than self-recall of affective experience that is distant in time such as within weeks, months or years as done in other studies (Doherty-Torstrick et al., 2016; Fergus & Dolan, 2014; Muse et al., 2012), it does not capture the affective state in real-time during the search process. It is possible that people's affective states might fluctuate during the search as a response to the information they read online (te Poel et al., 2016). Therefore, for people whose self-report of valence, arousal and control did not differ before and after the search, it does not necessarily mean that their affective states remained constant throughout the search.

Finally, data collected in the present study is only a snapshot of people's OHIS, which might not reflect real-life situations where people frequently and repeatedly engage in OHIS for the same or different health concerns. White and Horvitz (2009a) observed that some people searched for the same symptom repeatedly in days, weeks, or even months after the initial search. Such longitudinal data may provide additional insights about the relationships of health anxiety and OHIS that were not captured in the present study.

These limitations of this study could probably be addressed in future studies. An important direction that future research may consider is incorporating autonomic measures of affect (e.g. heart rate, galvanic skin responses, facial expression, pupil dilation) to complement self-report data. As data collected in a controlled experimental setting may not reflect people's day-to-day OHIS in real life, future study may consider taking a longitudinal and observational approach to study health anxious people's OHIS over an extended period of time in their natural settings.

This study is exploratory in nature and focused on a few key variables of OHIS that are mostly likely to be influenced by health anxiety as suggested by theories and findings of previous works. To extend the theoretical and practical implications of this work more broadly, future studies should consider exploring other cognitive, affective, and behavioral variables of OHIS and their relationships with health anxiety. One cognitive variable of potential interest is eHealth literacy, defined as "the ability to seek, find, understand and apprise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem (Norman & Skinner, 2006,

para. 1)". As discussed in Section 6.1.3, participants of higher health anxiety seemed to be more efficient with search as they spent less effort on search but were more likely to find the correct diagnosis. This could potentially be due to the fact that people with higher health anxiety practice more frequent OHIS (Baumgartner & Hartmann, 2011), and thus develop higher eHealth literacy over time. Future study could investigate whether or not eHealth literacy might play a role in moderating the relationships between health anxiety and OHIS.

Future studies could also consider investigating what information factors (e.g. the design of a website, the organization and tone of the Web content, and source of online information) might contribute to negative thinking and feeling. White and Horvitz (2009a) randomly selected and analyzed 6,000 Web pages to examine participants' search logs. They found that pages that led to escalated searches (a search that began with a benign symptom escalated to a search for a severe condition) shared one or multiple of the following features: serious illness information preceding benign explanation on the page, information about serious illness and benign explanation appearing together in the title close to the beginning of the page, and web pages from health forums. Similarly, Lauckner and Hsieh (2013) found that when severe conditions were presented before benign explanations, it exacerbated people's perception of the severity of the symptom and thus frightened them more. They also found that the more frequently a severe explanation was presented, the more likely people were to perceive a common symptom as a severe illness. Findings from these studies suggest that the organization of Web content might impact people's perception of illness information. Future studies may

consider investigating how different features of Web design might moderate the relationships between health anxiety and the cognitive, affective and behavioral dimension of OHIS.

6.4 CONCLUSION

As OHIS is becoming increasingly popular among health consumers (Fox & Duggan, 2013; Marrie et al., 2013), public concerns have raised about the potential negative impact of OHIS on people with high health anxiety (Starcevic, 2017). Despite a handful of pioneer studies have been done to investigate this potential problem (e.g., Baumgartner & Hartmann, 2011; Eastin & Guinsler, 2006; White & Horvitz, 2009a), gaps remain in understanding the relationships between health anxiety and OHIS. The goal of this dissertation study was to advance scientific knowledge about the relationships between health anxiety and OHIS.

Guided by the cognitive-behavioral model of health anxiety (Warwick, 1989; Warwick & Salkovskis, 1990), models of information seeking (Griffin, Dunwoody & Neuwirth, 1999; Kuhlthau, 2009; Nahl, 2007d), and findings of empirical studies (e.g. Baumgartner & Hartmann, 2011; Doherty-Torstrick et al., 2016; McManus et al., 2014), I developed the eHealth Anxiety Model (eHAM), and proposed a series of research hypotheses to investigate the relationships between health anxiety and the cognitive, affective, and behavioral dimensions of OHIS. To test the hypotheses, a quasi-experimental design with repeated measures was implemented in which participants with various levels of health anxiety were asked to complete a search task on a lab computer

and their cognitive (perceived health risk) and affective (valence, arousal and control) experience were measured before and after the search, and their behavioral experience (search effort and search accuracy) were measured during or after the search.

Results of the quantitative analysis revealed that health anxiety and online search had no statistically significant interaction effect on people's cognitive, affective and behavioral experience during OHIS. However, health anxiety did have a significant main effect on perceived health risk, negative valence and search accuracy. To be specific, participants with higher health anxiety perceived greater health risk about the illness scenario, experienced greater negative valence overall, and more likely to find the accurate diagnosis than those with lower health anxiety. Findings from the open-ended question found that people with higher health anxiety seemed to perceive the illness scenario as more severe than those with lower health anxiety, which is in line with the results of the quantitative analysis. In addition, many participants regardless of their health anxiety levels were aware of the potentially exaggerated nature of online heath information and were mindful of the credibility of online health information.

Appendices

APPENDIX A: QUESTIONNAIRES

Demographics

SID

_____

Age

_____

Gender

- ○ Male
- ○ Female
- ○ Other _____

What is your highest level of education?

- ○ No formal education
- ○ Less than high school graduate
- ○ High school graduate/GED
- ○ Vocational training
- ○ Some college/Associate's degree
- ○ Bachelor's degree (BA, BS)
- ○ Master's degree (or other post-graduate training)
- ○ Doctoral degree (PhD, MD, EdD, DDS, JD, etc.)

Do you consider yourself Hispanic or Latino?

- ○ Yes
- ○ No

How would you describe your primary racial group?

- ○ American Indian/Alaska Native
- ○ Asian
- ○ African American
- ○ Multi-racial
- ○ Native Hawaiian/Pacific Islander
- ○ White Caucasian
- ○ Other _____

In general, your health is

- ○ Excellent
- ○ Good
- ○ Average
- ○ Poor
- ○ Terrible

Are you a native English speaker?

- ○ Yes
- ○ No

Short Health Anxiety Inventory

Each of the following questions consists of a group of four statements. Please read each group of statements carefully and select one option that best describes your experience **over the past six months.**

Select one option that best describes your experience over the past six months.

- ○ I do not worry about my health
- ○ I occasionally worry about my health
- ○ I spend much of my time worrying about my health
- ○ I spend most of my time worrying about my health

Select one option that best describes your experience over the past six months.

- ○ I notice aches/pains less than most other people (of my age)
- ○ I notice aches/pains as much as most other people (of my age)
- ○ I notice aches/pains more than most other people (of my age)
- ○ I am aware of aches/pains in my body all the time

Select one option that best describes your experience over the past six months.

- ○ As a rule I am not aware of bodily sensations or changes
- ○ Sometimes I am aware of bodily sensations or changes
- ○ I am often aware of bodily sensations or changes
- ○ I am constantly aware of bodily sensations or changes

Select one option that best describes your experience over the past six months.

- ○ Resisting thoughts of illness is never a problem
- ○ Most of the time I can resist thoughts of illness
- ○ I try to resist thoughts of illness but am often unable to do so
- ○ Thoughts of illness are so strong that I no longer even try to resist them

Select one option that best describes your experience over the past six months.

- ○ As a rule I am not afraid that I have a serious illness
- ○ I am sometimes afraid that I have a serious illness
- ○ I am often afraid that I have a serious illness
- ○ I am always afraid that I have a serious illness

Select one option that best describes your experience over the past six months.

- ○ I do not have images (mental pictures) of myself being ill
- ○ I occasionally have images of myself being ill
- ○ I frequently have images of myself being ill
- ○ I constantly have images of myself being ill

Select one option that best describes your experience over the past six months.

- ○ I do not have any difficulty taking my mind off thoughts about my health
- ○ I sometimes have difficulty taking my mind off thoughts about my health
- ○ I often have difficulty taking my mind off thoughts about my health
- ○ Nothing can take my mind off thoughts about my health

Select one option that best describes your experience over the past six months.

- ○ I am lastingly relieved if my doctor tells me there is nothing wrong
- ○ I am initially relieved but the worries sometimes return later
- ○ I am initially relieved but the worries always return later
- ○ I am not relieved if my doctor tells me there is nothing wrong

Select one option that best describes your experience over the past six months.

- ○ If I hear about an illness I never think I have it myself
- ○ If I hear about an illness I sometimes think I have it myself
- ○ If I hear about an illness I often think I have it myself
- ○ If I hear about an illness I always think I have it myself

Select one option that best describes your experience over the past six months.

- ○ If I have a bodily sensation or change I rarely wonder what it means
- ○ If I have a bodily sensation or change I often wonder what it means
- ○ If I have a bodily sensation or change I always wonder what it means
- ○ If I have a bodily sensation or change I must know what it means

Select one option that best describes your experience over the past six months.

- ○ I usually feel at very low risk for developing a serious illness
- ○ I usually feel at fairly low risk for developing a serious illness
- ○ I usually feel at moderate risk for developing a serious illness
- ○ I usually feel at high risk for developing a serious illness

Select one option that best describes your experience over the past six months.

- ○ I never think I have a serious illness
- ○ I sometimes think I have a serious illness
- ○ I often think I have a serious illness
- ○ I usually think that I am seriously ill

Select one option that best describes your experience over the past six months.

- ○ If I notice an unexplained bodily sensation I don't find it difficult to think about other things
- ○ If I notice an unexplained bodily sensation I sometimes find it difficult to think about other things
- ○ If I notice an unexplained bodily sensation I often find it difficult to think about other things
- ○ If I notice an unexplained bodily sensation I always find it difficult to think about other things

Select one option that best describes your experience over the past six months.

- ○ My family/friends would say I do not worry enough about my health
- ○ My family/friends would say I have a normal attitude to my health
- ○ My family/friends would say I worry too much about my health
- ○ My family/friends would say I am a hypochondriac

For the following questions, please think about what it might be like if you had a serious illness of a type which particularly concerns you. Obviously you cannot know for sure what it would be like; please give your best estimate of what you think might happen, basing your estimate on what you know about yourself and serious illness in general.

Please think about what it might be like if you had a serious illness of a type which particularly concerns you.

- ○ If I had a serious illness I would still be able to enjoy things in my life quite a lot
- ○ If I had a serious illness I would still be able to enjoy things in my life a little
- ○ If I had a serious illness I would be almost completely unable to enjoy things in my life
- ○ If I had a serious illness I would be completely unable to enjoy life at all

Please think about what it might be like if you had a serious illness of a type which particularly concerns you.

- ○ If I developed a serious illness there is a good chance that modern medicine would be able to cure me
- ○ If I developed a serious illness there is a moderate chance that modern medicine would be able to cure me
- ○ If I developed a serious illness there is a very small chance that modern medicine would be able to cure me
- ○ If I developed a serious illness there is no chance that modern medicine would be able to cure me

Please think about what it might be like if you had a serious illness of a type which particularly concerns you.

- ○ A serious illness would ruin some aspects of my life
- ○ A serious illness would ruin many aspects of my life
- ○ A serious illness would ruin almost every aspect of my life
- ○ A serious illness would ruin every aspect of my life

Please think about what it might be like if you had a serious illness of a type which particularly concerns you.

- ○ If I had a serious illness I would not feel that I had lost my dignity
- ○ If I had a serious illness I would feel that I had lost a little of my dignity
- ○ If I had a serious illness I would feel that I had lost quite a lot of my dignity
- ○ If I had a serious illness I would feel that I had totally lost my dignity

Perceived health risk (pre-search)

Before you perform any research on the Internet, I'd like to ask for your opinions about the illness case you just read. Please read the following statements carefully, and for each statement, select one option that best reflects your opinion about the illness case based on the best of your knowledge.

The described illness is very serious.

- ○ Completely disagree
- ○ Disagree
- ○ Neither agree or disagree
- ○ Agree
- ○ Completely agree

It is very likely that I may experience the same or similar illness in the future.

- ○ Completely disagree
- ○ Disagree
- ○ Neither agree or disagree
- ○ Agree
- ○ Completely agree

If in the affected person's situation, I don't think I can cope with the illness myself.

- ○ Completely disagree
- ○ Disagree
- ○ Neither agree or disagree
- ○ Agree
- ○ Completely agree

If in the affected person's situation, I cannot trust the doctors to take care of me.

- ○ Completely disagree
- ○ Disagree
- ○ Neither agree or disagree
- ○ Agree
- ○ Completely agree

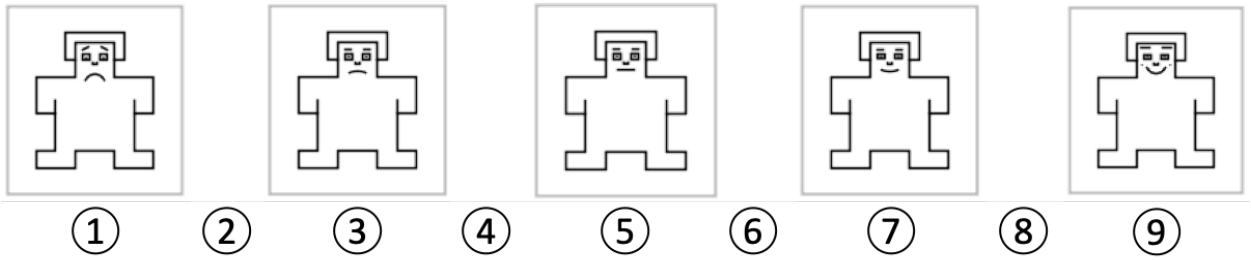
Self-Assessment Manikin (pre-search)

The images below show three different kinds of feelings: unhappy vs. happy, calm vs. excited, and controlled vs. in control. **Imagine that you are in the affected person's situation as described in the illness case, and use the images below to rate your feelings.**

This row shows the **unhappy-happy** scale. There are a total of 9 possible points along the rating scale. Check one circle to indicate the extent to which you are feeling unhappy or happy **if you are in the affected person's situation**.

- The left end of this scale indicates that you are feeling completely unhappy, annoyed, unsatisfied, melancholic, despaired, or bored. If you are feeling completely unhappy, you should check the circle below the figure at the most left.
- The right end of this scale indicates that you are feeling completely happy, pleased, satisfied, contented, hopeful. If you are feeling completely happy, you should check the circle below the figure at the most right.
- If you are feeling completely neutral, neither happy nor sad, check the circle below the figure in the middle.
- The remaining two figures allow you to describe intermediate feelings of pleasure, by checking the circle below one of the two figures.
- If your feeling of pleasure or displeasure falls between two of the figures, then check the circle in the space between the figures. This permits you to make more finely graded ratings of how you feel.

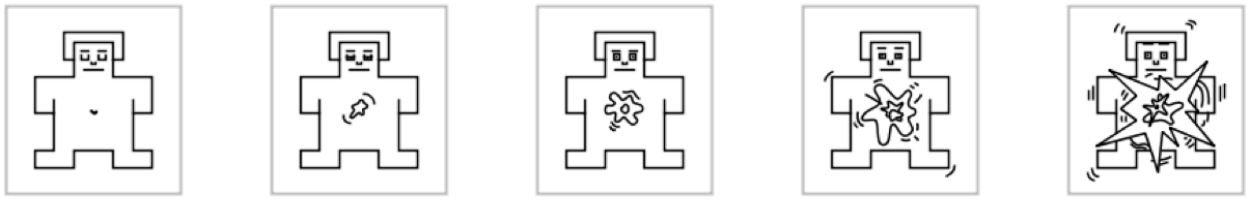
Unhappy - Happy



This row shows the **calm-excited** scale. There are a total of 9 possible points along the rating scale. Check one circle to indicate the extent to which you are feeling calm or excited if you are in the affected person's situation.

- The left end of the scale indicates that you are feeling completely relaxed, calm, sluggish, dull, sleepy, or unaroused.
- The right end of the scale indicates that you are feeling completely stimulated, excited, frenzied, jittery, wide-awake, or aroused.
- If you are feeling completely calm, check the circle below the figure at the most left.
- If you are feeling completely aroused, check the circle below the figure at the most right.
- If you are not excited nor at all calm, check the circle below the figure in the middle.
- The remaining two figures allow you to describe intermediate feelings of excitement or calmness, by checking the circle below one of the two figures.
- If you wish to make a more finely tuned rating of how excited or calm you are feeling, check the circle falling in between the figures.

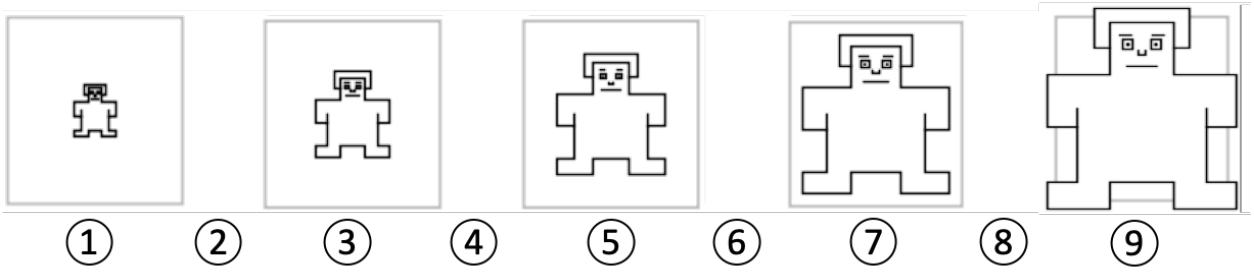
Calm - Excited



This row of images indicates to what extend you are feeling **controlled-in control**. There are a total of 9 possible points along the rating scale. Check one circle to indicate the extent to which you are feeling controlled or in-control if you are in the affected person's situation.

- The left end of the scale indicates that you have feelings characterized as completely controlled, influenced, awed, or submissive. If you are feeling completely controlled, check the circle below the figure at the most left.
- The right end of the scale indicates that you are feeling completely in control, influential, dominant, autonomous, or controlling.
- If you are feeling completely in-control, check the circle below the figure at the most right.
- If you feel neither in control nor controlled, check the circle below the figure in the middle.
- The remaining two figures allow you to describe intermediate feelings of controlled or in-control, by checking the circle below one of the two figures.
- If you wish to make a more finely tuned rating of how controlled or in-control you are feeling, check the circle falling in between the figures.

Controlled - In Control



Open-ended question

You have answered all the questions. Now you can conduct an online search using Google Chrome to find out what disease the affected person may be suffering. There may be many possible diagnoses, but **choose only one** that you think is the most likely disease. After completing the search, come back to this survey to answer the questions below.

Please write down the name of one most likely diagnosis for the illness case based on the information you found online.

_____

_____

_____

_____

_____

Please describe the search process (e.g. the steps you took, your thinking process and feelings at each step)

_____

_____

_____

_____

_____

Perceived health risk (post-search)

Now you've done some research on the Internet about the illness case. I'd like to ask you again for your opinion about the illness case. Please read the following statements carefully. For each statement, select one option that best reflects your opinion about the illness case based on the best of your knowledge and the information you found online.

The described illness is very serious.

- ○ Completely disagree
- ○ Disagree
- ○ Neither agree or disagree
- ○ Agree
- ○ Completely agree

It is very likely that I may experience the same or similar illness in the future.

- ○ Completely disagree
- ○ Disagree
- ○ Neither agree or disagree
- ○ Agree
- ○ Completely agree

If in the affected person's situation, I don't think I can cope with the illness myself.

- ○ Completely disagree
- ○ Disagree
- ○ Neither agree or disagree
- ○ Agree
- ○ Completely agree

If in the affected person's situation, I cannot trust the doctors to take care of me.

- ○ Completely disagree
- ○ Disagree
- ○ Neither agree or disagree
- ○ Agree
- ○ Completely agree

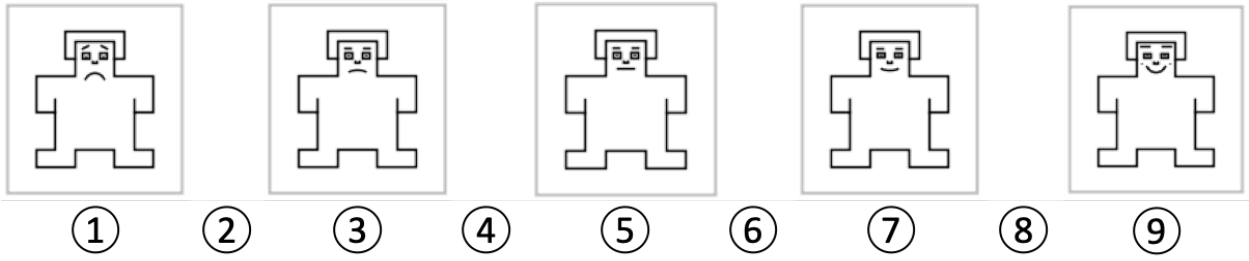
Self-Assessment Manikin (post-search)

After learning more information about the illness case from doing online search. **Imagine that you are in the affected person's situation as described in the illness case**, use the following images to rate your feelings.

This row shows the **unhappy-happy** scale. There are a total of 9 possible points along the rating scale. Check one circle to indicate the extent to which you are feeling unhappy or happy **if you are in the affected person's situation**.

- The left end of this scale indicates that you are feeling completely unhappy, annoyed, unsatisfied, melancholic, despaired, or bored. If you are feeling completely unhappy, you should check the circle below the figure at the most left.
- The right end of this scale indicates that you are feeling completely happy, pleased, satisfied, contented, hopeful. If you are feeling completely happy, you should check the circle below the figure at the most right.
- If you are feeling completely neutral, neither happy nor sad, check the circle below the figure in the middle.
- The remaining two figures allow you to describe intermediate feelings of pleasure, by checking the circle below one of the two figures.
- If your feeling of pleasure or displeasure falls between two of the figures, then check the circle in the space between the figures. This permits you to make more finely graded ratings of how you feel.

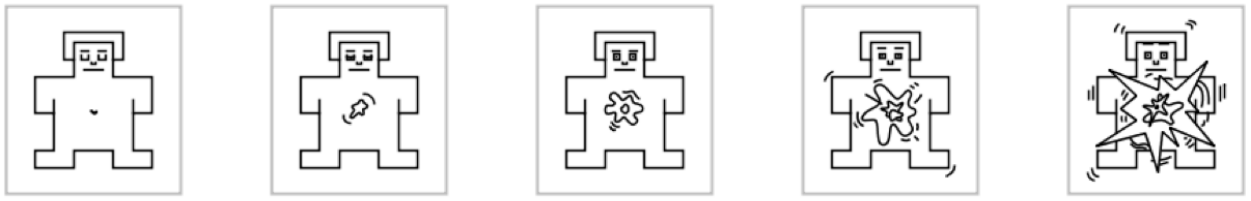
Unhappy - Happy



This row shows the **calm-excited** scale. There are a total of 9 possible points along the rating scale. Check one circle to indicate the extent to which you are feeling calm or excited if you are in the affected person's situation.

- The left end of the scale indicates that you are feeling completely relaxed, calm, sluggish, dull, sleepy, or unaroused.
- The right end of the scale indicates that you are feeling completely stimulated, excited, frenzied, jittery, wide-awake, or aroused.
- If you are feeling completely calm, check the circle below the figure at the most left.
- If you are feeling completely aroused, check the circle below the figure at the most right.
- If you are not excited nor at all calm, check the circle below the figure in the middle.
- The remaining two figures allow you to describe intermediate feelings of excitement or calmness, by checking the circle below one of the two figures.
- If you wish to make a more finely tuned rating of how excited or calm you are feeling, check the circle falling in between the figures.

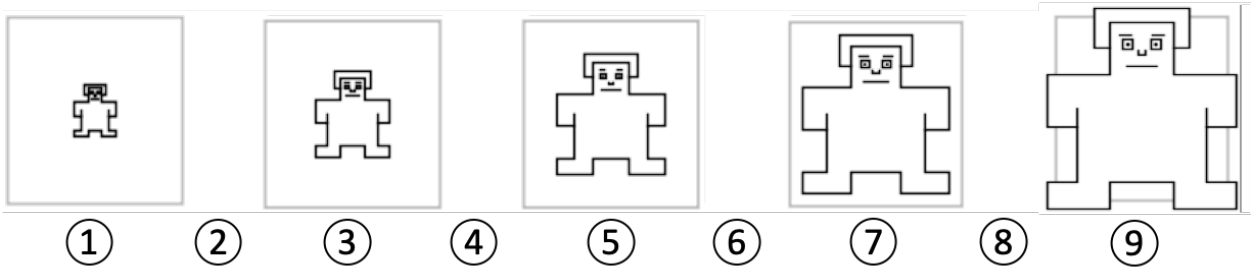
Calm - Excited



This row of images indicates to what extend you are feeling **controlled-in control**. There are a total of 9 possible points along the rating scale. Check one circle to indicate the extent to which you are feeling controlled or in-control if you are in the affected person's situation.

- The left end of the scale indicates that you have feelings characterized as completely controlled, influenced, awed, or submissive. If you are feeling completely controlled, check the circle below the figure at the most left.
- The right end of the scale indicates that you are feeling completely in control, influential, dominant, autonomous, or controlling.
- If you are feeling completely in-control, check the circle below the figure at the most right.
- If you feel neither in control nor controlled, check the circle below the figure in the middle.
- The remaining two figures allow you to describe intermediate feelings of controlled or in-control, by checking the circle below one of the two figures.
- If you wish to make a more finely tuned rating of how controlled or in-control you are feeling, check the circle falling in between the figures.

Controlled - In Control

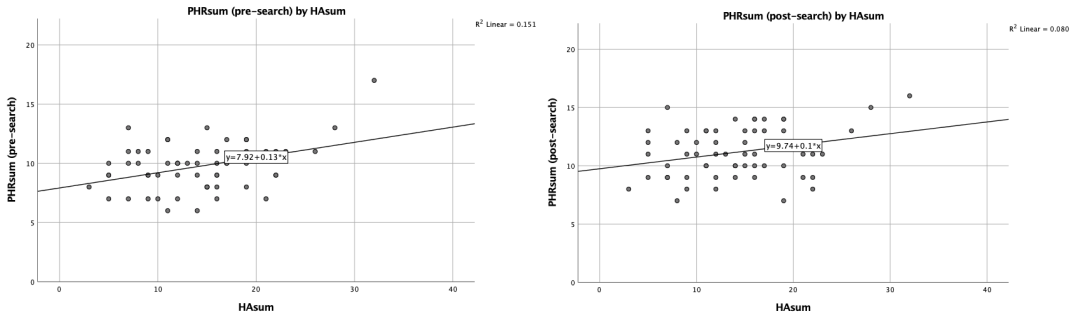


APPENDIX B: TESTING RESULTS OF STATISTICAL ASSUMPTIONS

1. Testing of statistical assumptions for linear mixed model

1.1. Linear mixed model for perceived health risk pre- and post-search (PHRsum pre-search and PHRsum post-search) ~ health anxiety (HAsum)

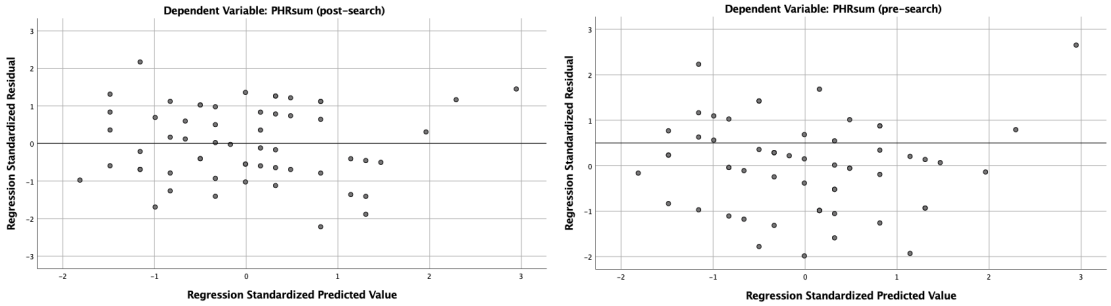
1.1.1. Linearity: Visual inspection of the scatterplots indicated a linear relationship between the variables.



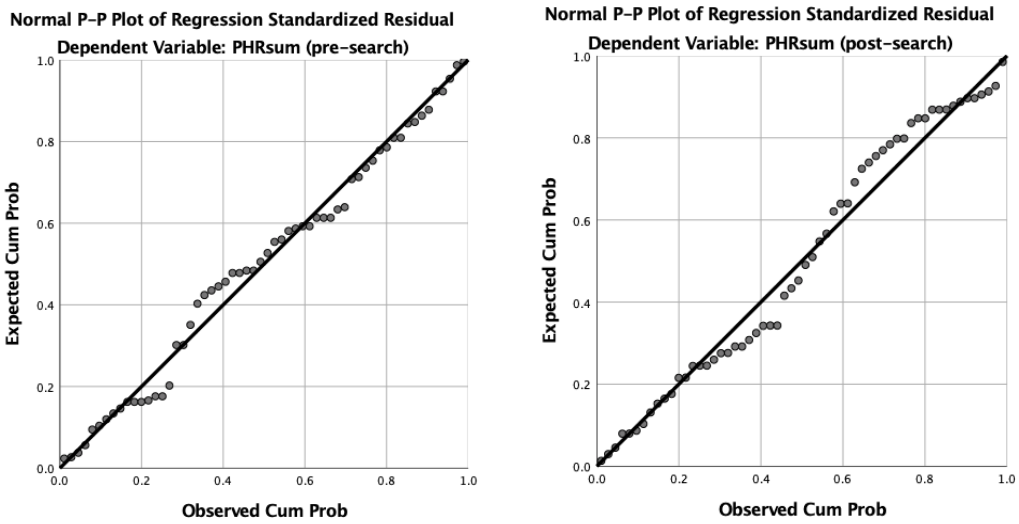
1.1.2. Independence of residuals: There was independence of residuals for both PHRsum pre-search and PHRsum post-search as a function of HAsum, as assessed by Durbin-Watson statistic of 1.530 and 1.949, respectively.

1.1.3. Absence of outliers: There was absence of outliers for both PHRsum pre-search and PHRsum post-search, as assessed by Casewise Diagnostics in SPSS.

1.1.4. Homoskedasticity: There was homoscedasticity as assessed by visual inspection of the residual plots.

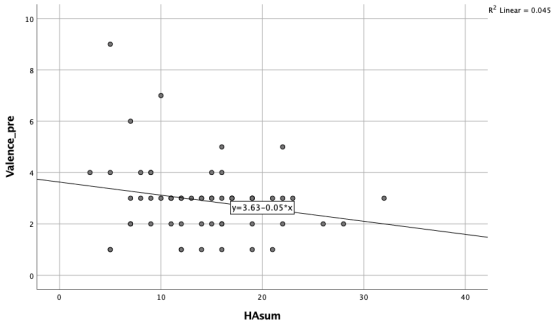


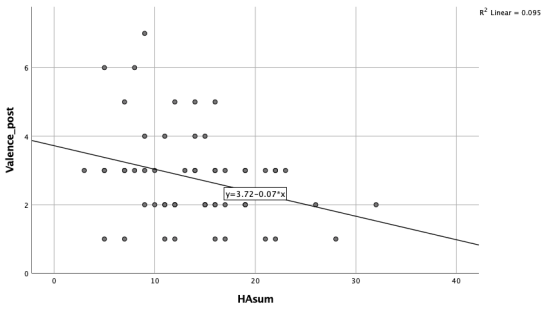
1.1.5. Normality of residuals: Residuals for both PHRsum pre-search and PHRsum post-search were normally distributed as assessed by visual inspection of normal probability plots.



1.2. Linear mixed model for valence pre- and post-search (Valence_pre and Valence_post) ~ health anxiety (HAsum)

1.2.1. Linearity: Visual inspection of the scatterplots indicated somewhat of a linear relationship between the variables.

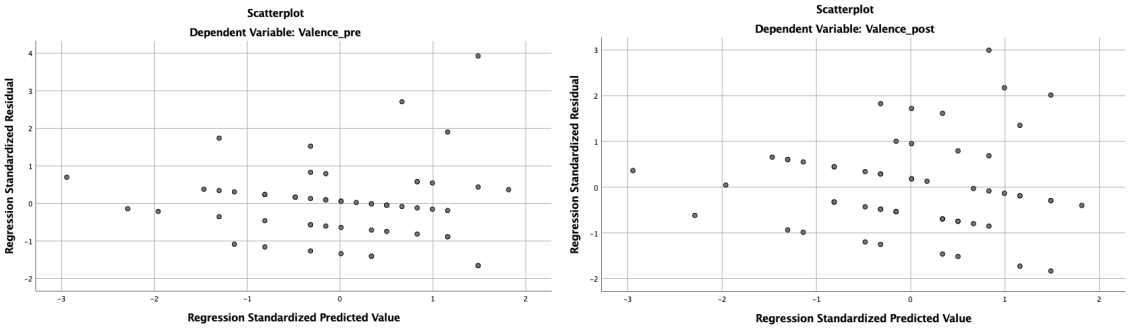




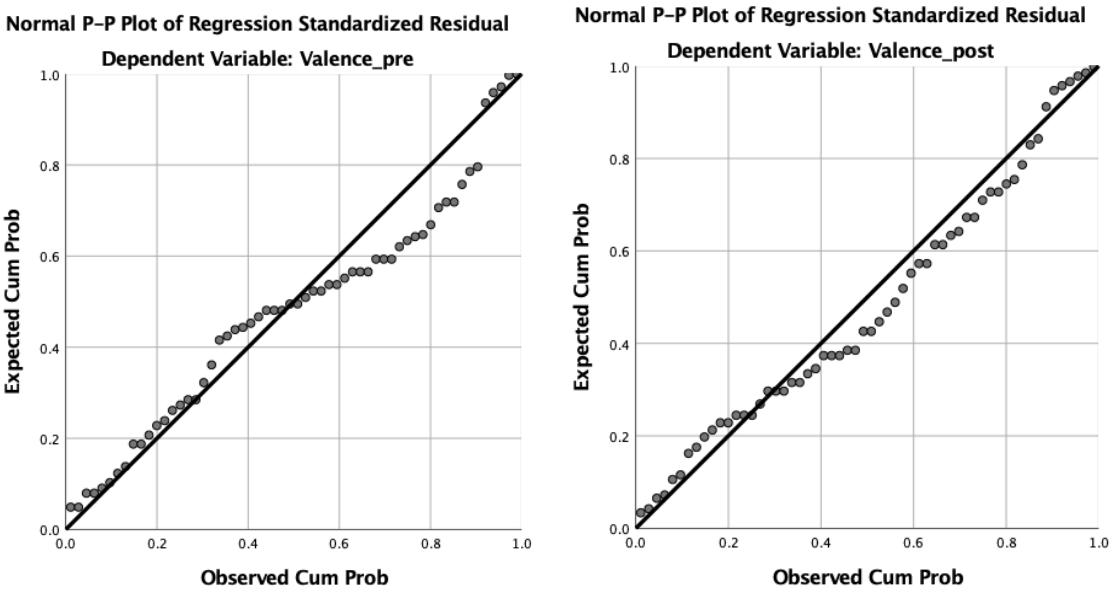
1.2.2. Independence of residuals: There was independence of residuals for both Valence_pre and Valence_post as a function of HAsum, as assessed by Durbin-Watson statistic of 2.018 and 2.331, respectively.

1.2.3. Absence of outliers: There was one outlier for Valence_pre, and no outlier was identified for Valence_post as assessed by Casewise Diagnostics in SPSS. The outlier was likely due to misinterpretation of the scale. One participant rated Valence_pre as 9 “extremely happy”, which is quite unlikely to be true. Analysis was run for data with and without the outlier and showed no significant difference. Thus, the outlier was retained in the analysis.

1.2.4. Homoskedasticity: There was homoscedasticity as assessed by visual inspection of the residual plots.

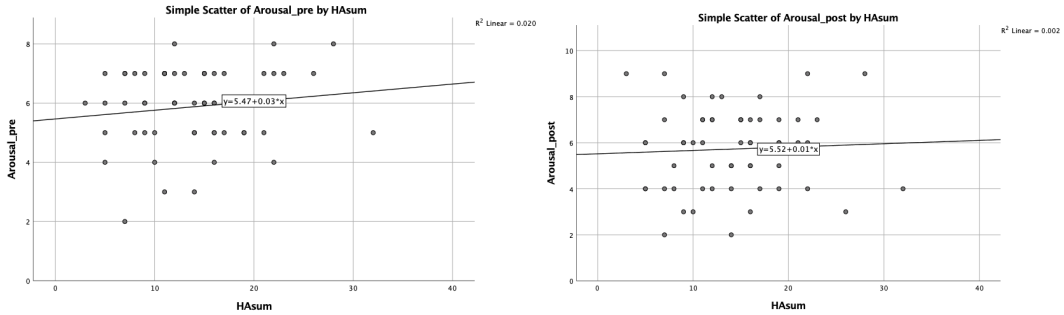


1.2.5. Normality of residuals: Residuals for both Valence (pre-search) and Valence (post-search) were normally distributed as assessed by visual inspection of normal probability plots.



1.3. Linear mixed model for arousal pre- and post-search (Arousal_pre and Arousal_post) ~ health anxiety (HAsum)

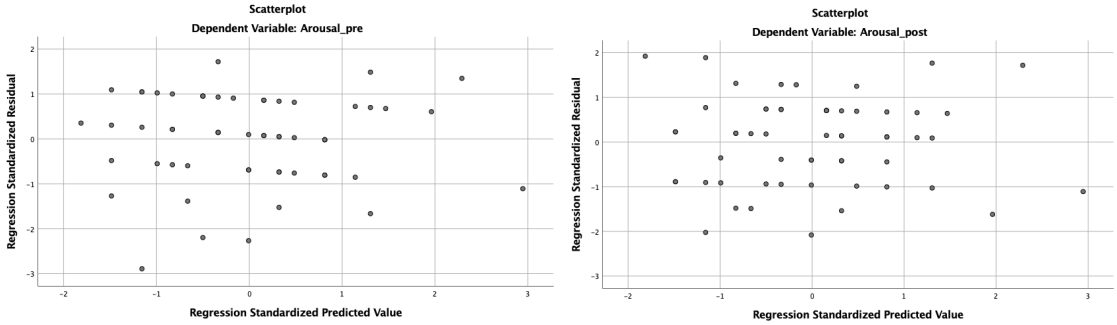
1.3.1. Linearity: Visual inspection of the scatterplots indicated somewhat of a linear relationship between the variables.



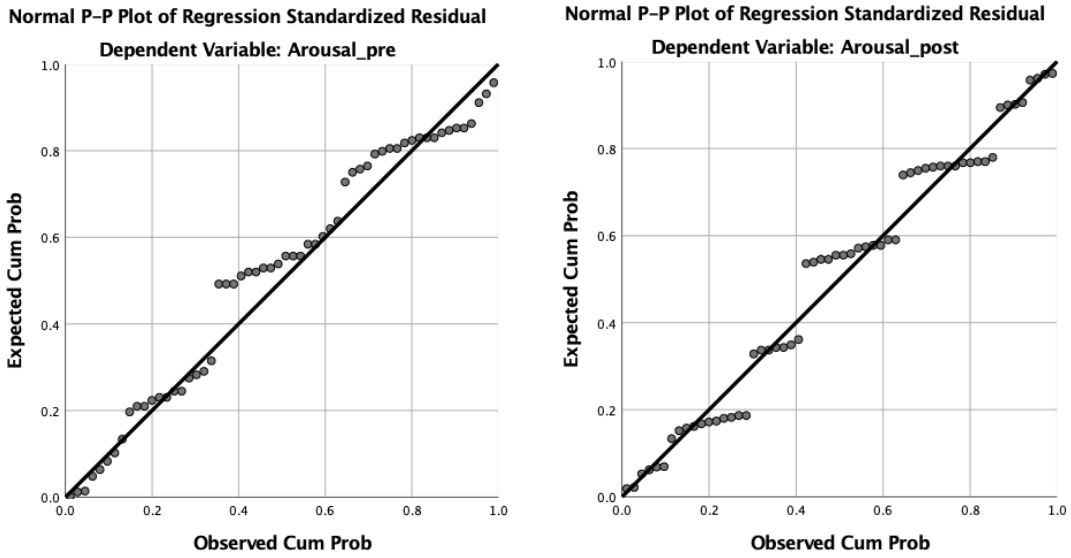
1.3.2. Independence of residuals: There was independence of residuals for both Arousal_pre and Arousal_post as a function of HAsum, as assessed by Durbin-Watson statistic of 1.815 and 2.072, respectively.

1.3.3. Absence of unusual data points (outliers): There was absence of outliers for both Arousal_pre and Arousal_post, as assessed by Casewise Diagnostics in SPSS.

1.3.4. Homoskedasticity: There was homoscedasticity as assessed by visual inspection of the residual plots.

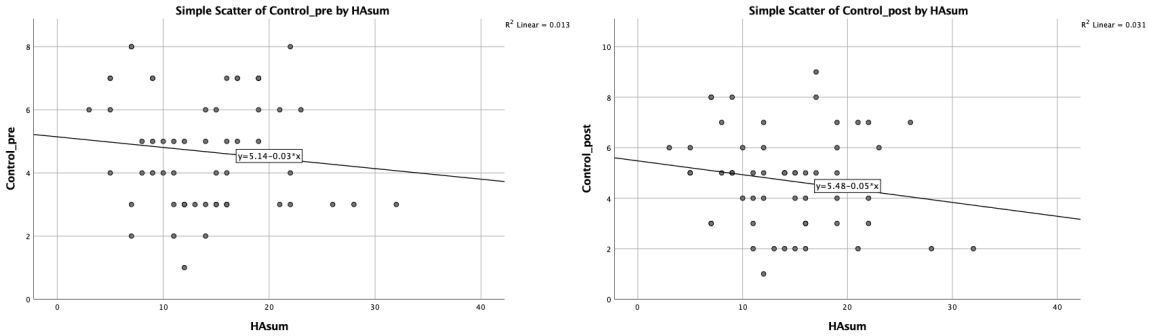


1.3.5. Normality of residuals: Residuals for both Arousal (pre-search) and Arousal (post-search) were somewhat normally distributed as assessed by visual inspection of normal probability plots.



1.4. Linear mixed model for control pre- and post-search (Control_pre and Control_post) ~ health anxiety (HAsum)

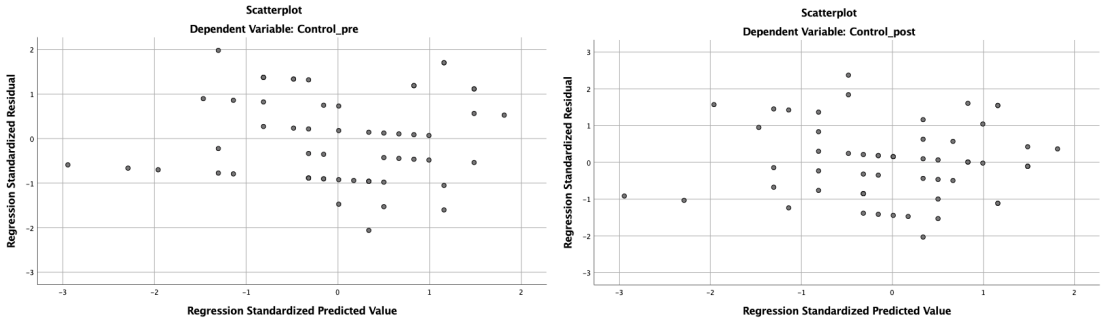
1.4.1. Linearity: Visual inspection of the scatterplots indicated a linear relationship between the variables.



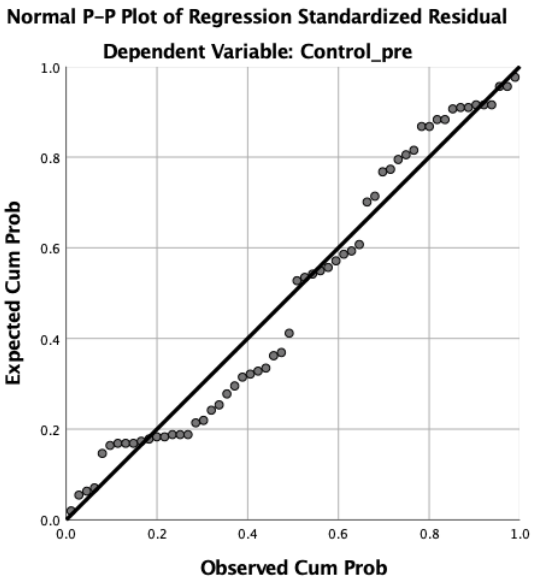
1.4.2. Independence of residuals: There was independence of residuals for both Control_pre and Control_post as a function of HAsum, as assessed by Durbin-Watson statistic of 2.087 and 2.431, respectively.

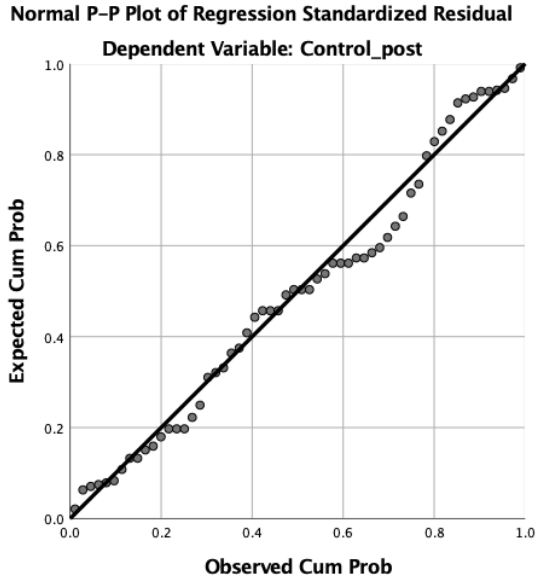
1.4.3. Absence of unusual data points (outliers): There was absence of outliers for both Control_pre and Control_post, as assessed by Casewise Diagnostics in SPSS.

1.4.4. Homoskedasticity: There was homoscedasticity as assessed by visual inspection of the residual plots.



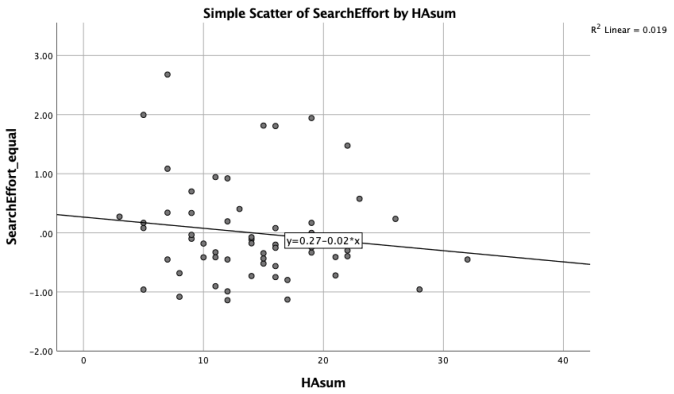
1.4.5. Normality of residuals: Residuals for both Control_pre and Control_post were normally distributed as assessed by visual inspection of normal probability plots.





2. Simple linear regression for search effort (SearchEffort) ~ health anxiety (HAsum)

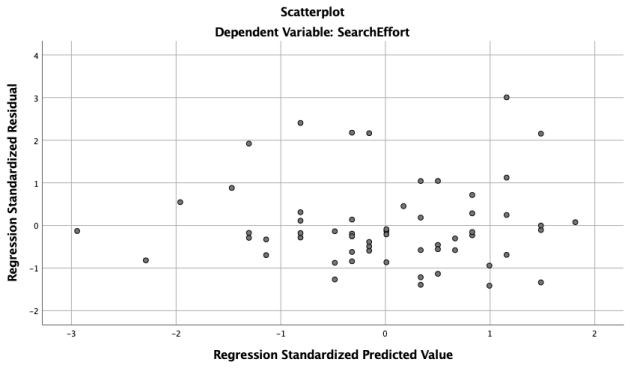
2.1. Linearity: Visual inspection of the scatterplots indicated a linear relationship between the variables.



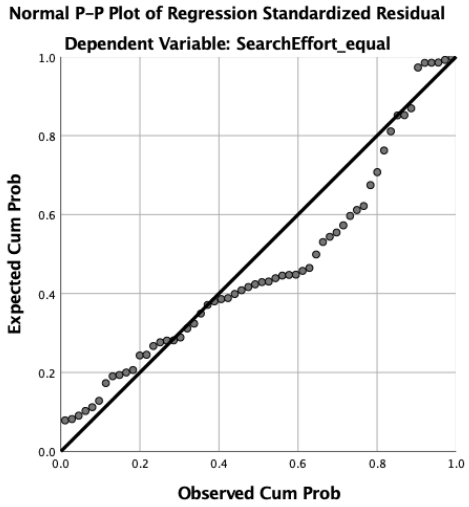
2.2. Independence of residuals: There was independence of residuals for SearchEffort as a function of HAsum, as assessed by Durbin-Watson statistic of 1.959.

2.3. Absence of unusual data points (outliers): There was one outlier for SearchEffort as assessed by Casewise Diagnostics in SPSS, and it was retained in the analysis.

2.4. Homoskedasticity: There was homoscedasticity as assessed by visual inspection of the residual plots.



2.5. Normality of residuals: Residuals for SearchEffort was normally distributed as assessed by visual inspection of normal probability plots.



3. Binominal logistic regression for search accuracy (SearchAccuracy) ~ health anxiety (HAsum)

3.1. Linearity: Linearity of the continuous independent variable health anxiety with respect to the logit of the dependent variable was assessed via the Box-Tidewell procedure. A Bonferroni correction was applied using the two terms in the model resulting in statistical significance being accepted when $p < 0.025$. Based on this assessment, health anxiety was found to be linearly related to the logit of search accuracy.

3.2. Absence of outliers: There was no standardized residual in the data.

APPENDIX C: INFORMED CONSENT FORM

Informed Consent Form for Participating in the Lab Study

1. Introduction

You are invited to participate in a research study conducted by Jin Gao, a Ph.D. candidate at the School of Information at the University Texas at Austin, as part of her dissertation research. The purpose of this study is to understand people's experience with online health information search. Read the information below and ask any questions you might have. If you agree to participate, please sign your name at the end of this form.

Below is an overview of the session procedure:

Step	Description	Time (min)
1	Researcher introduces the research background and procedure, and obtain signed consent from the participants	10
2	Participants complete a background questionnaire	10
3	Participants read an illness case	5
4	Participants complete the prior-to-search questionnaire	5
5	Participants perform an online search to find out the diagnosis for the illness case	20
6	Participants write down one most possible diagnosis for the illness case, rationale for the diagnosis, and the web URLs from which they obtained the information that helps them make the diagnoses	10
7	Participants complete the post-search questionnaire	5
	Total	~80

2. What will you be asked to do if agree to participate in this study?

Upon arrival at the lab, you will first be asked to fill out a questionnaire which asks about your demographic information (e.g. age, gender and education) and your opinions about health. Then you will be instructed to perform one health-related search task on the Internet using a lab computer. Before starting and after completing the search task, you will be asked to fill out a questionnaire. During the search, your screen activities (e.g. mouse clicks and text entry) will be recorded.

3. What are my confidentiality or privacy protections if agree to participate in this research study?

This research is confidential. If you agree to participate, you will be assigned a code that will be placed on the questionnaire forms and other collected data. Your name will not appear on any questionnaire forms and other collected data. Your name will also not appear on any report or article associated with this research; only the assigned code

will be used. This unique code along with your contact information (email and phone numbers) that you were asked to provide prior to coming to the lab will be kept in a file stored on the researcher's personal computer that is protected by a password only known by the researcher. This signed consent form will be locked in the file cabinet that is only accessible by the researcher and will be destroyed after 3 years following the close of the study.

4. What are the risks involved in this study?

The risks associated with this study are minimal and not greater than what you would experience in the course of everyday life.

5. What are the possible benefits of this study?

There is no direct benefit for participating in the study. Your participation may advance our understanding about the challenges and problems people may encounter during online health information search, and thus provide valuable insights to researchers and information system designers to develop better programs that satisfy people's health information needs.

6. Do you have to participate?

Your participation is voluntary. You may decide not to participate at all or discontinue participation at any time.

7. Will there be any compensation?

All qualified participants will be compensated with a free meal at the beginning or the end of the study session.

8. Whom to contact with questions about the study?

If you have any questions about this study, you can contact the researcher, Jin Gao at (832) 472-6255 or send an email to jin.gao@utexas.edu. If you have any questions or concerns as a research subject, you can contact the Institutional Review Board at the University of Texas at Austin at (512) 471-8871 or email at orsc@uts.cc.utexas.edu.

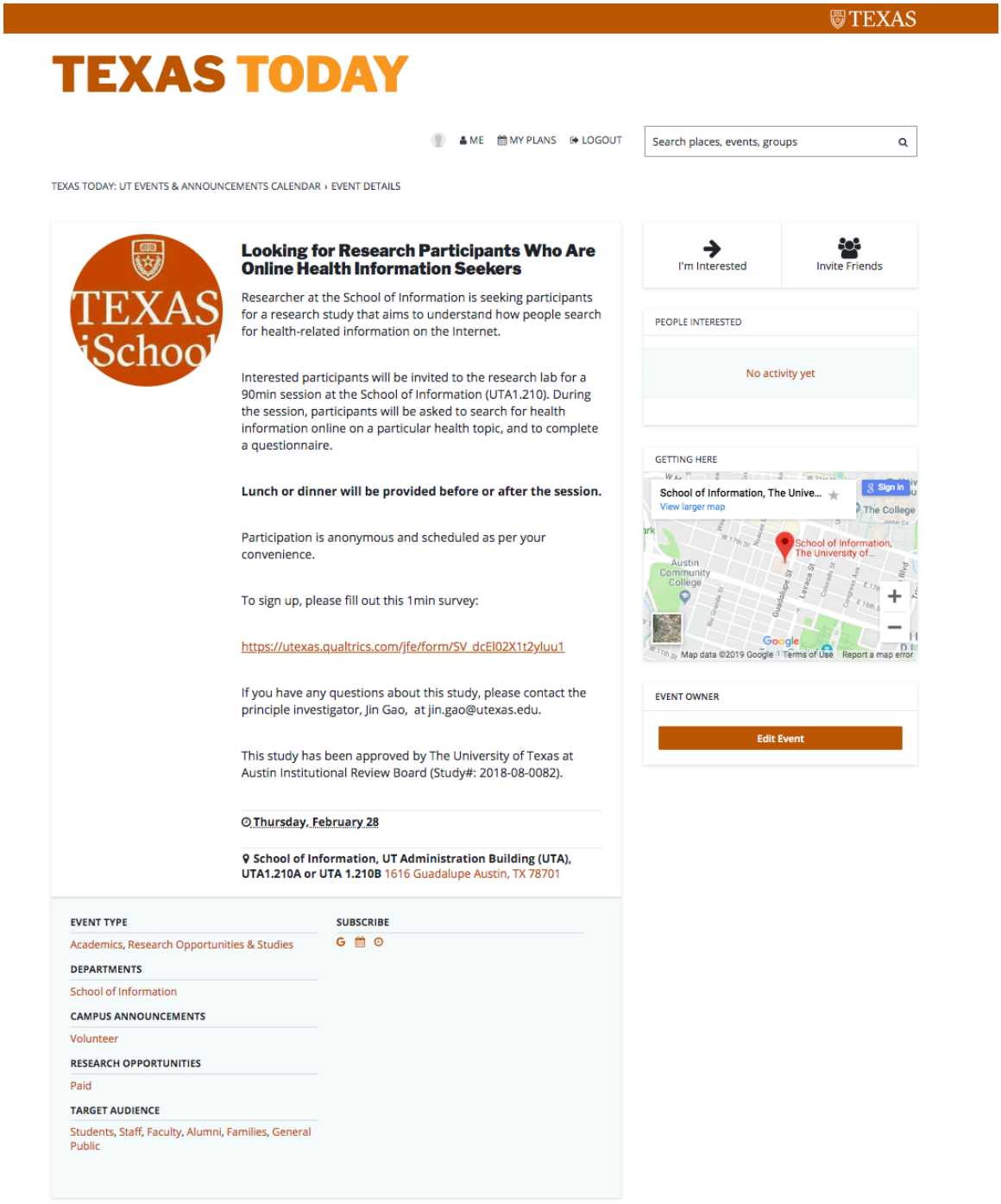
9. Consent to participation

You have been informed about this study's purpose, procedures, possible benefits and risks, and you have received a copy of this form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time. You voluntarily agree to participate in this study. By signing this form, you are not waiving any of your legal rights.

_____
Printed Name

_____ _____
Signature Date

APPENDIX D: RECRUITMENT POST AND FLYER



The University of Texas at Austin
School of Information

Research Participants Wanted ! ! !

Researcher at the iSchool is seeking participants for a research study that aims to understand how people search for health-related information on the Internet.

You will be invited to the research lab at the iSchool (UTA 1.210) for a 1.5-hour session. During the session, participants will be asked to search for health information online on a particular health topic, and to complete a questionnaire.

Lunch or Dinner Will Be Provided!

Participation is anonymous and scheduled as per your convenience.

Interested? To see if you qualify, please fill out this form:

https://utexas.qualtrics.com/jfe/form/SV_dcEl02X1t2yluu1

Questions? Email the Principal Investigator, Jin Gao, at **jin.gao@utexas.edu**

This study has been approved by the Institutional Review Board at UT Austin (Study#: 2018-08-0082)

APPENDIX E: SCREENING SURVEY

Thank you for your interest in participating in this research study. The purpose of this study is to understand people's experience with online health information search. Participation in this study would require a 1-hour visit to the research lab at the School of Information at the University of Texas at Austin, located at the UTA Building 5.516, 1616 Guadalupe Street Austin, Austin TX. This study has been approved by the Institutional Review Board at the University of Texas at Austin (Study#: 2018-08-0082).

To see if you might qualify for this study, please answer a few questions in this survey. In the end of the survey, you will be asked to provide your contact information (email and phone number). The researcher will contact you later to schedule an appointment with you (if you qualify). If you have any question about this research study, you can contact the principle investigator, Jin Gao, at jin.gao@utexas.edu.

Are you 18 or older?

- ○ Yes
- ○ No

Have you studied or obtained professional training in health and medical related domains? (e.g. medicine, nursing, pharmacy)

- ○ Yes
- ○ No

How comfortable are you using Google Chrome to search for information on the Internet?

- ○ I never used Google Chrome to search for information on the Internet
- ○ I don't know how to use Google Chrome to search for information on the Internet
- ○ I feel very uncomfortable to use Google Chrome to search for information on the Internet
- ○ I feel uncomfortable to use Google Chrome to search for information on the Internet
- ○ I feel neither comfortable nor uncomfortable to use Google Chrome to search for information on the Internet
- ○ I feel comfortable to use Google Chrome to search for information on the Internet
- ○ I feel very comfortable to use Google Chrome to search for information on the Internet

Please provide your contact information below. Please note that your contact information will only be used to schedule an appointment (if you qualify). Your contact information will not be used in any other way, and will be kept private to the researcher only.

Email address

_____

Best phone number to call

_____

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